INDUSTRIAL ENGINEERING

COVERING THE PLANT ENGINEERING FUNCTION IN INDUSTRY

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433

Plant Engineers and Their Function

. . . For the betterment of industry it is desirable that functions in industrial plants be clearly defined.

. . . Everyone knows fairly well what a president is supposed to do. There is little confusion regarding the duties of secretaries, treasurers, cost accountants, and the like.

. . . Works managers, production managers, superintendents, foremen work along lines that for the most part run true courses.

. . . The titles these men carry are indicative of their work; the functions cleave along natural lines.

. . . Confusing, however, are the engineer titles and the engineer functions. Engineer, chief engineer, works engineer, plant engineer, design engineer, tool engineer, production engineer, efficiency engineer—who does what? For a long time there have not been clear lines of functionalization. Probably some confusion will exist for a long time to come.

. . . To some extent, fortunately, there is clarification. Out of the engineer title-function maze "plant engineer" as a title and "plant engineering" as a function are emerging. Only slightly recognized three or four years ago, these terms today are approaching wide recognition.

. . . The "engineering of the plant" is the simplest definition of this function. In effect the duties are to keep the plant in such condition that the primary objective of the plant—the production of the plant's products for sale—can be accomplished economically and efficiently.

. . . In detail the function involves, basically, the maintenance of the plant structures themselves; the selection, installation, operation, and maintenance of the mechanical and electrical equipment that are a part of the plant; and the control and operation of such services as lighting, heating, ventilating, and protection against fire. There are included the duties of installing the production machines, supplying them with power transmission equipment, and maintaining them.

. . . The function of plant engineering is somewhat obscured by such titles as maintenance engineer, master mechanic, chief electrician and others carried by the men who are responsible for the function. It is flourishing, nevertheless, as shown by the "organization" articles appearing in *Industrial Engineering,** which describe examples of existing practice. There remains to be brought about a wider adoption of the title "plant engineer" and a more universal recognition of the boundary lines of the function.

* See page 464, this issue.

THE INDUSTRIAL FIRE D

FIRE protection has always been a problem of first importance to the General Electric Company in the operation of its various plants. Since its organization, 40 years ago, fire losses have been remarkably low, due principally to the efficiency of the fire protection and inspection systems. The Schenectady Works, because of the large amount of equipment involved and the large number of people employed, has the most extensive fire protection facilities of any of the plants.

Equipment

Building No. 45, centrally located inside the plant, is the heart of the entire protection system. In this building are located the fire chief's office, the central alarm panel with its signal stations situated throughout the plant, and the mobile fire apparatus and its personnel.

The fire alarm system consists of signal boxes in each of the buildings, the box number corresponding to the building number on the central alarm panel in the fire chief's office. In the case of multi-story buildings the floor number is added to the box or building number. Regular tests are made over the system to insure its proper operation, a test signal being sent out daily when the noon whistle is blown.

The fire apparatus, also housed in the central fire station, consists of one electric auto truck, one hose truck and a ladder truck. In addition to the above equipment, there are located at strategic points throughout the plant, additional hose carts each with its crew of regular workers from the nearest buildings who respond with their apparatus to alarms of fire.

The storage battery auto truck is equipped with 1,200 ft. of 2½-in. fire hose, soda and acid, foam, carbon tetrachloride and carbon dioxide fire extinguishers. It also carries a foam generator and 800 lb. of foam powder. Waterproof covers, salvage tools, wool and asbestos blankets and a full complement of gas masks, axes, bars, pike poles, door-openers, etc., complete the list of its equipment.

The hose and ladder trucks are smaller sized vehicles but also contain complete equipment including hand extinguishers, axes, hooks, etc. These are hand drawn and are manned by the regular firemen and a call company of workmen from the building nearest the central fire station.

In the factory buildings the equipment consists of soda and acid, foam, carbon tetrachloride, and CO_2 extinguishers, wool and asbestos blankets, gas masks, fire pails, sand, sawdust, and inside fire plugs and hose lines generously located.

The workmen are instructed in the use of these extinguishers in quenching small fires, and controlling fires of more serious proportions until the fire department arrives.

All buildings are of the slow-burning type and are fully protected by an automatic sprinkler system.

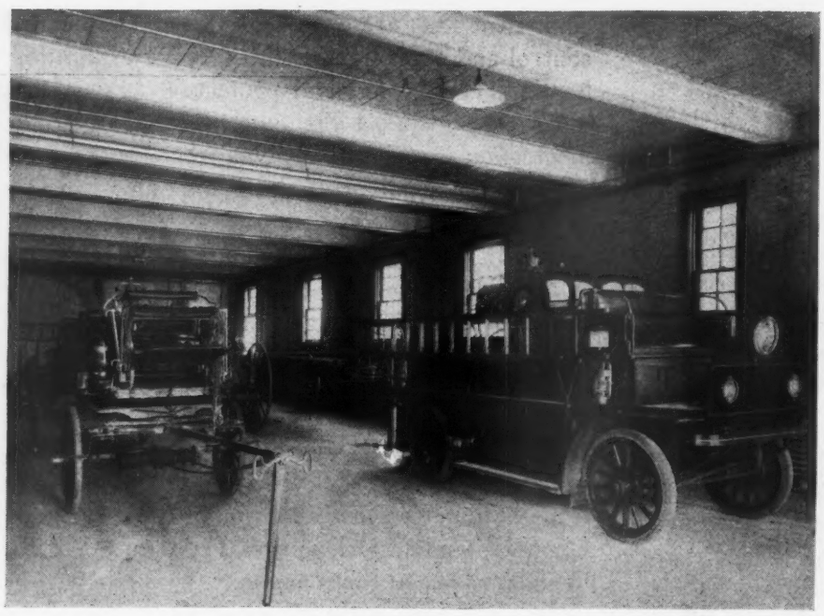
Organization

The permanent fire department consists of seven men: the fire chief, an assistant chief, three inspectors, and two maintenance men. These men are the personnel quartered in Building No. 45, and previously referred to. In addition to the seven regular firemen there are 250 shop employees scattered throughout the plant subject to call in cases of fire and grouped into companies. Upon the receipt of an alarm of fire they respond to their respective hose houses and from there take their equipment to the fire.

There are nine fire companies in the department. Each company is comprised of a captain, a lieutenant, a senior hoseman, and hosemen. With the exception of the night fire company and the central fire house company on duty in the daytime, all of the companies are call companies of men from the various shops.

When a fire occurs the alarm is sounded on the regulation box gongs in all the shops. One company covers the central fire station. All but two of the remaining companies respond to the alarm, that is, proceed to their respective hose houses and thence to the scene of the fire with their apparatus. These two companies, stationed at extreme ends of the works, do not respond immediately to an alarm and their consequent action is determined in the following manner: The one nearest the scene of the fire responds to the first alarm. The other remains in its place in the shop and awaits a second call or an alarm for another fire. All companies respond to the second alarm.

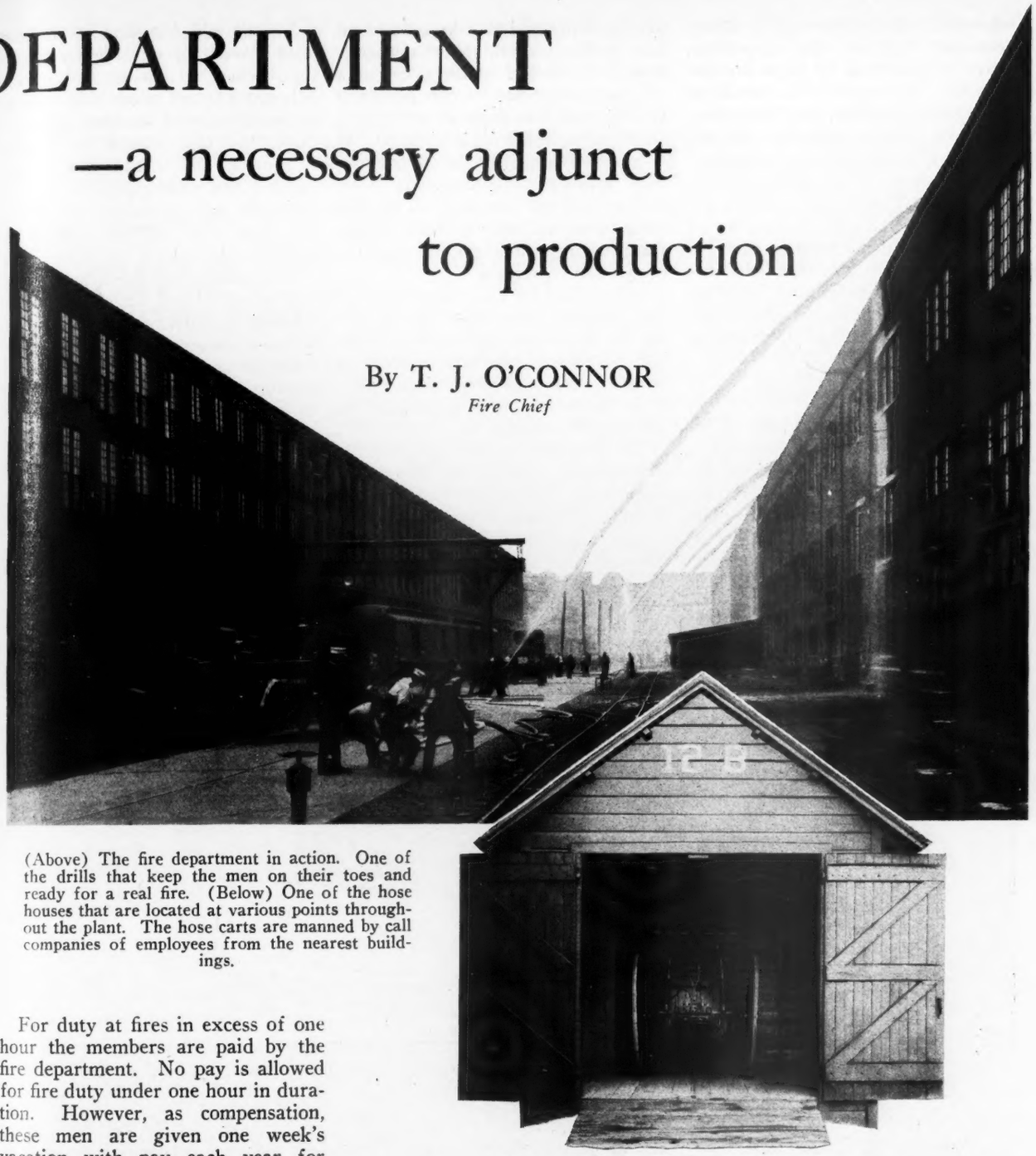
Upon arriving at a fire the company commanders report to the officer in charge, and, if their services are required they are immediately assigned for duty, otherwise they are ordered to return to quarters and their places in the shops.



The central fire station, Building No. 45. In addition to the fire apparatus shown, this building also contains the fire chief's office and the central fire alarm panel.

E DEPARTMENT —a necessary adjunct to production

By T. J. O'CONNOR
Fire Chief



(Above) The fire department in action. One of the drills that keep the men on their toes and ready for a real fire. (Below) One of the hose houses that are located at various points throughout the plant. The hose carts are manned by call companies of employees from the nearest buildings.

For duty at fires in excess of one hour the members are paid by the fire department. No pay is allowed for fire duty under one hour in duration. However, as compensation, these men are given one week's vacation with pay each year for serving as firemen. The members of the fire department are appointed from the various buildings upon the recommendation of their foremen and are assigned to the nearest fire companies.

Fire Drills

Fire drills are held twice a month during April, May, June, July, August, September, and October and once a month in November, December, January and February. During the winter months lectures are given on fire protection, fire extinguishing, and fire prevention by the chief of the department in the hall in the central fire station. During the months of April and May the fire companies test all hose lines and fire plugs in the shops, flushing out all lines. Defective hose is immediately replaced and repairs of the fire plug systems are made. During the months of May and June the fire companies are given individual company drills, the officers of the companies being in charge. At these drills the men are tuned up for the regular bell alarm drills which are held during the months of July, August, September, and October. A box is pulled and the companies respond just as at an actual fire. There is no previous knowledge of the alarm location; the companies respond, report in, and are assigned their work just as if an actual fire were in progress. A second alarm is pulled at these drills and the entire department responds. Usually each company lays two lines to the location where a fire is supposed to be in progress and the ladder company places its ladders, opens up the building, and performs ventilating duty. When all lines are laid and ladders are in position the lines are

inspected and corrections made where necessary. After this inspection, water is passed in all lines for five minutes. This makes an excellent drill, giving the men real hose duty, and some valuable experience in team work. After the drill each company makes up, returns to quarters, and is dismissed. This drill also keeps our hose and hydrants in working order, and flushes out the water mains.

Exit fire drills also, are held once a month in all our factory buildings two stories and over in height and where there are at least 25 people on the second floor.

Fire Prevention

Inspections are made daily by the members of the fire department in their respective shops. All the fire appliances in their sections are checked to see that they are in place and ready for immediate service. The men also inspect the sprinkler valves and fire plug main valves in their sections to see that they are open and that the system is in service. Special hazards are checked, and the section is given a good inspection for general order and neatness. Each man is instructed to take care of all fires in his section, report sprinkler leaks, etc., and if in the event of a fire he thinks that he can handle it readily with two pails of water or a small extinguisher he is to do so. If a hose stream from an inside fire plug appears to be necessary he is first to pull the box and call the fire department and then go back and do what he can to hold the fire until the department arrives.

When the fireman completes his daily inspection he reports in by calling the fire department office where the result of his investigation is entered on a daily inspection report. This blank is shown in an accompanying illustration.

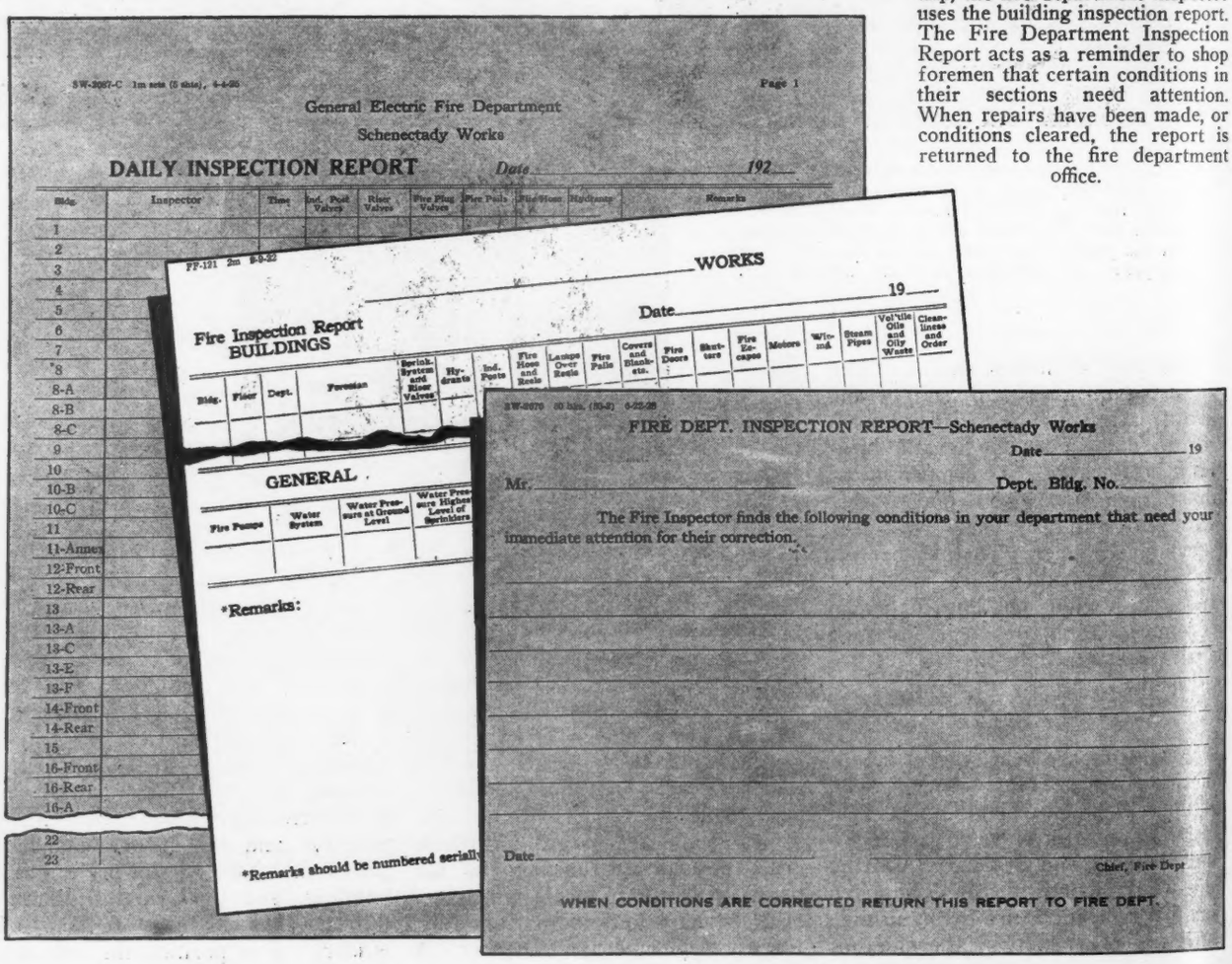
The buildings are inspected once a month by the regular fire department inspectors. Notes are taken and a check-up is made every day. Shop orders are issued to cover repairs. Unsatisfactory conditions are taken up directly with the shop foreman and a memorandum of the condition is also sent the foreman the next day. This memorandum must be returned to the fire department office when the conditions are again satisfactory.

The sprinkler system is inspected once a week by our regular inspectors, when all inside and outside valves are tested to see that they are open and in good working order. An inspection tag, signed by the inspector, is tied to the wheel of the valve. The underground valves and hydrants are inspected weekly, as are also the company hose and hydrant houses.

We use the red tag system where valves are closed on our sprinkler, fireplug or yard main systems. No water is shut off on any of these systems unless the order comes through the fire department office. The piper calls at the office, reports the job he proposes to do and, if conditions are all right to shut the water off in that building at that particular time, a red tag is issued. The tag has a stub and is made out in duplicate, the valve number, the building number and a description of the job being

* * * *

The Daily Inspection Report, telephoned to the central fire station, is a record of the inspections made by the firemen in their respective shops. On his monthly trip, the fire department inspector uses the building inspection report. The Fire Department Inspection Report acts as a reminder to shop foremen that certain conditions in their sections need attention. When repairs have been made, or conditions cleared, the report is returned to the fire department office.



SW-2067-C 1m sets (5 slots), 6-4-26 Page 1

General Electric Fire Department

Schenectady Works

DAILY INSPECTION REPORT Date 192

Bldg.	Inspector	Time	Ind. Post Valves	Riser Valves	Fire Plug Valves	Fire Pails	Fire Hose	Hydrants	Remarks
1									
2									
3									
4									
5									
6									
7									
8									
8-A									
8-B									
8-C									
9									
10									
10-B									
10-C									
11									
11-Annex									
12-Front									
12-Rear									
13									
13-A									
13-C									
13-E									
13-F									
14-Front									
14-Rear									
15									
16-Front									
16-Rear									
16-A									
22									
23									

FF-121 2m 8-9-22

WORKS

Date 19

Fire Inspection Report
BUILDINGS

Bldg.	Floor	Dept.	Foreman	Sprink. System and Riser Valves	Hydrants	Ind. Posts	Fire Hose and Reels	Leakage Over Reels	Fire Pails	Covers and Blankets	Fire Doors	Shutters	Fire Escapes	Motors	Wiring	Steam Pipes	Volatile Oils and Oily Waste	Cleanliness and Order

GENERAL

Fire Pumps	Water System	Water Pressure at Ground Level	Water Pressure Highest Level of Sprinklers

*Remarks:

*Remarks should be numbered serially

SW-2070 50 hds. (10-F) 6-22-26

FIRE DEPT. INSPECTION REPORT—Schenectady Works

Date 19

Mr. Dept. Bldg. No.

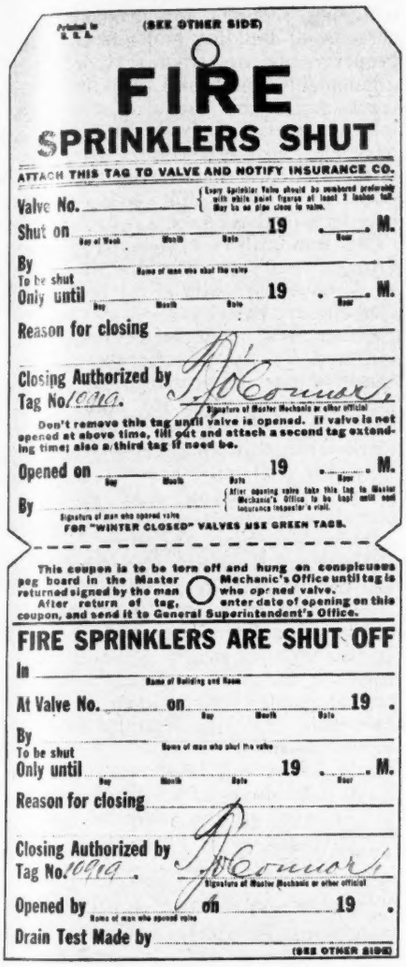
The Fire Inspector finds the following conditions in your department that need your immediate attention for their correction.

Date

Chief, Fire Dept.

WHEN CONDITIONS ARE CORRECTED RETURN THIS REPORT TO FIRE DEPT.

entered on both tag and stub. The piper signs both and proceeds to the job where he closes the sprinkler valve and attaches the red tag. The stub is placed on a hook on a sprinkler shut-off valve-board in the fire department office. The name of the fireman in the building where the job


(SEE OTHER SIDE)
FIRE
SPRINKLERS SHUT
ATTACH THIS TAG TO VALVE AND NOTIFY INSURANCE CO.
Valve No.
Shut on 19 M.
By
To be shut Only until 19 M.
Reason for closing
Closing Authorized by
Tag No. 1019.
Don't remove this tag until valve is opened. If valve is not opened at above time, fill out and attach a second tag extending time; also a third tag if need be.
Opened on 19 M.
By
FOR "WINTER CLOSED" VALVES USE GREEN TAGS.
This coupon is to be torn off and hung on conspicuous peg board in the Master Mechanic's Office until tag is returned signed by the man who opened valve. After return of tag, enter date of opening on this coupon, and send it to General Superintendent's Office.
FIRE SPRINKLERS ARE SHUT OFF
In
At Valve No. on 19
By
To be shut Only until 19 M.
Reason for closing
Closing Authorized by
Tag No. 1019.
Opened by on 19
Drain Test Made by
(SEE OTHER SIDE)

This tag is tied to the wheel of every sprinkler valve that is closed for repairs. The stub is detached and placed on a sprinkler shut-off valve-board in the fire chief's office until repairs have been made and the valve is again open and ready for service.

* * * *

is to be done is placed on the tag and he inspects the job and looks after the section while the sprinkler system is out of service. When the job has been completed the piper opens the valve and reports it O. K. to the fireman in the building. This fireman inspects the job and tests the sprinkler to see that it is fully open, and then signs the tag. The tag is taken to the fire department office where it and the stub are signed by the piper. The tag is taken up by one of our regular inspectors, who also inspects the job and tries the valve to see that it is fully open, after which he seals it in this position. The tag is again returned to the fire department office to be held until the visit of the insurance inspector.

A record of all closed valves and of tags issued, complete with the history of each job, is entered in a book in the fire department office. This much is done to avoid the closed sprinkler valve hazard.

Inspection and Watchman Service

An important factor which has helped us maintain our excellent fire record is the inspection service rendered by the insurance company. A complete inspection of the plant, its hazards and protection equipment, is made four times a year. This service includes inspection of the plant buildings, hose and hydrant systems, water mains, the sprinkler system, and the fire apparatus.

The company is very much interested in the reports of the insurance inspector and feel that they are of considerable value. In fact the plans for all new buildings that the company erects are first submitted to the engineering department of the insurance company for approval, special attention to be given to the water and sprinkler systems. This arrangement no doubt has contributed to the excellent record which the company has enjoyed since its organization.

Fire Losses

That the company has had a remarkable low fire record is further evidenced by the fact that for the last ten years the losses have averaged about $17,000 a year for 20 plants; an average of less than $1,000 per plant per year. The largest single loss that the company has suffered, as far as available records show, was somewhat less than $40,000. A permanent record is kept of all fires which are afterward investigated and the causes determined.

The company realizes that costly interruptions to production, caused by fire, are usually the result of carelessness and negligence and, with this in mind, has devoted much time and effort in minimizing and, where possible, eliminating such conditions.

It Pays to Know Your Wire Rope Before Ordering

(Discussion)

By K. D. ROTHSCHILD, M. E.

THE article under the title given above, appearing in your July issue, is very good and certainly helpful. There has been so much misinformation handed down from time immemorial in wire rope articles that it is a pleasure to read an article of this kind.

However, I am not entirely in accord with one idea which seems to perpetuate itself, as to the wearing surface of Lang Lay. While it is true that a wire is exposed at each point where it comes to the surface for about three times the length, it is also buried three times as much. Mathematically, there are only six points touching the true circle, whether it be Lang Lay or Regular Lay. This prolonged, *exposed* surface (rather than *increased*) is one of the disadvantages of Lang Lay.

I should venture to say that if the worn areas, as shown in Fig. 2, page 378, were measured, the total worn areas of both samples would be approximately the same, assuming that both ropes have received the same amount of service at the same place and were originally composed of the same steel; but the illustration, such as it is, shows approximately, from the mere ocular inspection, the same amount of worn area.

Lang Lay rope has some advantages for some particular purposes, but in passing over sheaves and drums it has a milling action which not only grinds out the sheaves but itself also. I am not putting this point forward in deprecation of Lang Lay for it has its uses and for some requirements is better suited than other types of rope. The only reason I am mentioning this is that the very feature that is brought out as an advantage is in reality a disadvantage.

I feel confident some engineers will disagree with the ideas set forth. Still I do not believe any wire rope manufacturer who is really up and observant will disagree. The discussion of almost any angle of wire rope is similar to postmortems of a trial. Expert witnesses might testify to any kind of contradictory evidence.

PRACTICAL BOOKS

Electrical Engineering Problems—Part II, Alternating Current Circuits and Apparatus

By John G. Pertsch, Jr., Late Professor of Electrical Engineering, Cornell University. Prepared for publication by E. M. Strong, Instructor in Electrical Engineering, Cornell University. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Cloth 6x9 in., 105 pages, illustrated.

THIS volume is a companion to "Electrical Engineering Problems —Part I, Direct-Current Circuits and Apparatus" by the same author. Both books have been developed from sets of problems that were used for a number of years in courses given to junior students in electrical engineering at Cornell University.

It is the object of this work to provide a classified series of concrete problems suitable for use in the elementary study of alternating-current circuits and apparatus.

Direct-Current Electricity

By L. Raymond Smith, Instructor in Industrial Physics, William L. Dickinson High School, Jersey City, N. J. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York, N. Y. Cloth, 5 x 8 in., 262 pages; illustrated. Price $2.

AN elementary text book, suitable for use in teaching apprentices. No previous electrical knowledge on the part of the pupil is assumed. The text treats of circuits, resistance, batteries, magnets, generators, motors, measuring instruments, and related subjects.

Code of Minimum Requirements for Heating and Ventilation of Buildings

Published by the American Society of Heating and Ventilating Engineers, 29 W. Thirty-Ninth St., New York, N. Y. Edition of 1929; 158 pages, illustrated, flexible, loose-leaf binder, 6x9 in., price $5.

AS a result of numerous requests made to the Society by engineers, architects, municipalities, engineering and trade organizations, the Code of Minimum Requirements was developed, the purpose of which is to standardize as far as practicable the installation of heating and ventilation equipment. It represents minimum requirements as called for by good engineering practice. It has been prepared in loose-leaf form so that revision or enlargement from time to time, to keep pace with engineering development, will be easy and will permit the user to replace the various sections quickly as occasion requires. The adoption and use of this code will go far toward the elimination of "rule of thumb" methods, which in the past have been the source of much confusion and disappointing results.

Applications of formulas, diagrams and tables are illustrated by examples when thought necessary to explain the applications fully. There are twelve main sections and two appendixes to the code. The information contained therein is believed to represent the minimum requirements as called for by good practice at present; a leeway or deviation, however, is in some cases specified to cover slight discrepancies in measurements and so on.

American Standards Yearbook, 1929

Published by the American Standards Association, 29 W. 39th St., New York, N. Y. Paper binding, size 7¾x10½ in., 87 pages. Price, $1.

IMPORTANT developments in the national standardization activities of almost every major American industry are described in this book. It contains a review of the national industrial standardization movement during the past twelve months and covers mechanical, electrical, building, transportation, mining, textile, and many other industries.

Robert P. Lamont, U. S. Secretary of Commerce, in a foreword to the Year Book says: "The continued growth of interest at home and abroad in industrial standardization reflects its increasing importance in the world's commerce.

"Through its application, the economies of mass production are rapidly extending to consumer goods, resulting in the wider distribution and consumption of many of those hitherto classed as luxuries.

"The exchange of goods between countries will be facilitated by standardization international in its character. As this exchange is perfected, there will be an advance in world living standards, through the increased diffusion of wealth.

"The American Standards Association plays a most important part in this development by serving as the agency through which American industry and business cooperate in the formulation and promotion of standards.

"Its possibilities for further service in this direction fully warrant the continued and enlarged support of American industry."

Part of the Year Book is devoted to a detailed explanation of what the association is and its ultimate purposes. It lists new standards completed under the auspices of the American Standards Association during the past year and which include: a group of 19 specifications and methods of test for various petroleum products; a comprehensive code for protection against lightning, including sections for protections of persons, of building and miscellaneous property, and of structures containing inflammable liquids and gases; standard track gages and car sizes for metal mines; a group of six specifications for bare and insulated copper wire (this is the first time that standard specifications for cotton, silk and enameled magnet wire have been available); two more standards for pipe flanges and fittings; and specifications for track work, covering material for both steam and electric railways.

Other new projects mentioned and initiated by the association include: specifications for pressure and vacuum gages; specifications for leather belting; specifications for materials and workmanship for plastering; specifications for coal mine cars; and a comprehensive code on mine timbering, including specifications for timber and a code of timbering practice.

The Year Book lists altogether about 150 national standards which have already been completed and about 175 other national projects now under way. It also includes nearly 550 trade associations, technical societies and other organizations which have been cooperating in the establishment of industrial standards under the association's procedure and approximately 2,200 individuals who have been active in the work of the technical committees engaged on the projects.

Arc Welding, Lincoln Prize Papers

Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Cloth, 6x9 in., 421 pages, illustrated. Price $5.

SEVEN of the papers submitted to the American Society of Mechanical Engineers in the Lincoln Arc Welding Prize Contest—the three prize papers, the two that received honorable mention, and two other outstanding papers are published under the above title—because they contain so much of value and benefit to all those interested in the advancement of the art of arc welding and to all those making practical use of the art, says the editor, Edward Pierce Hulse.

The paper selected for the first prize of $10,000 is entitled "Arc Welding—Its Fundamentals and Economics." By James W. Owens, Director of Welding, Newport News Shipbuilding and Dry Dock Company, Newport News, Va. It is a treatise on the fundamentals of arc-welded design and shop practice and an analysis of its industrial applications and world-wide possibilities.

Variable-Speed Drives for Long Conveyor Chains

IN THE preceding article in the August issue, the author discussed a novel method of driving long, constant-speed conveyor chains from two or more points. Further details of the control equipment are given in this article, together with essential data on the layout of variable-speed conveyor chain drives employing two or more direct-current motors.

By ROBERT W. DRAKE

Consulting Engineer
McCormick Works, International Harvester Company
Chicago, Ill.

THE preceding article discussed at some length the use of slipring motors with resistance in the secondary circuit for driving constant-speed conveyor chains. The control for such drives and the layout of variable-speed chain drives will be considered in this article.

In Fig. 1 is shown a schematic diagram of the control, as worked out for two slipring motors driving one chain. Fig. 2 gives a similar schematic diagram for the main power wiring.

In Fig. 3 a complete wiring diagram is shown. This looks like a complicated control for so simple an application, but it can be simplified somewhat. With almost no changes except the addition of more relays and contactors, this control system can be extended to include as many motors as may be desired on one conveyor.

A small, triple-pole, non-automatic, oil circuit breaker is used as a disconnecting switch on this installation, as on every motor installation in this plant between 3-hp. and 100-hp. rating. The somewhat cheaper inclosed, air-break safety switches are not used because oil-immersed controls seldom open under rated load, never require cleaning and, furthermore, never cause manufacturing delays from heating due to contact oxidation.

Next comes a standard across-the-line type of push-button starter with time-delay, overload protection. The overload protection offers short-circuit protection in case of failure of the stator winding on either motor and satisfies the city inspection requirements. As protection against excessive stresses in the driven chain it is worthless, as explained below.

A 0.5-amp. contactor is used simply to control the operating solenoids of two larger contactors described later and to avoid undesirable backfeeds (sneaks) under certain circumstances. This little contactor can be eliminated entirely by a slight change in the internal (factory) wiring of the linestarter described above. However, we decided against this. We stock these linestarters in the storeroom. If one burns out any motor inspector would naturally replace it with a spare starter having standard wiring, in which case this job would not function properly.

The error would not be self-evident; that is, the motors would start, but certain protective features would not function if needed. Of course, we could stencil a warning on the outside of the starter and paste a wiring diagram on the inside of the cover. Then the delay due to failure of this starter would be increased, for the motor inspector would be obliged to study the diagram and change the wiring inside the spare starter. There would also be the chance that no one would remember to stencil the spare starter and that the original starter when repaired would go back into general stock, with its off-standard internal connections, causing a long and puzzling delay somewhere.

Previous to the installation of this scheme of dual drive for this chain, there had been many costly and annoying delays from the failure of the mechanically-synchronized dual drive formerly in use. It was considered of paramount importance that accurate, instantaneous overload protection be provided, so that under no circumstances could the motor build up tension on the chain sufficient to pull down corners, break corner supports, etc.

Now, we must understand that full load on the chain is by no means full load on the motor. As stated in the preceding article, it is necessary to use a motor rated at two to four times maximum operating load, on account of the greatly reduced starting torque resulting from the excessive secondary resistance used in this case.

It is not practicable to obtain any reasonable sensitivity of load-limiting protection on a small, standard induction motor at one-fourth to one-half rated load by means of current relays in the primary. The primary current at no load, principally wattless magnetizing current, is more than half full-load current; in the smaller sizes it is more than three-quarters full-load current. The variation in current with a change of load from one-sixth to one-third full load is very small; actually it is decidedly less than the variation in current at one-sixth full load, due to a 10 per cent change in voltage. Such protection would obviously be useless for this application.

Instead we put our instantaneous relays in the secondary, or rotor circuit. The rotor current is quite closely proportional to the motor torque, even with considerable secondary resistance. We have thus ob-

tained a simple and sensitive relay protection.

These secondary relays must be instantaneous. If something jams along the chain, an ordinary, time-delay relay designed to hold long enough so that it would not trip out on the starting rush of the motor, would hold in long enough to build up excessive chain tensions, and break something. We must have instantaneous relays. Such relays will, however, trip out during the starting period. Therefore, we had to make them inoperative during the starting period.

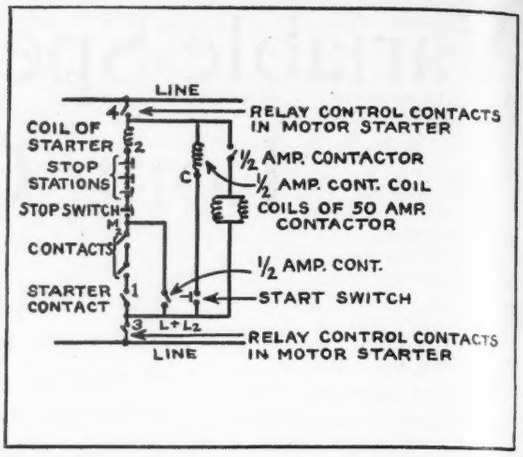


Fig. 1 — Schematic control diagram for two a.c. motors driving a constant-speed conveyor chain.

This we did at first by shunting out the relay coils during the starting period by means of two contactors, one contactor for each relay; that is, for each drive motor on the chain. This procedure, it must be admitted, involves one objectionable feature: The operator must hold in the starter button until the motors are up to speed, or the relay will shut them down again. If the chain jams during this period there is no protection. Indeed, this is really not so unlikely as it seems.

Suppose that the chain jammed back inside an oven. The drive stopped—a millwright inspected the chain and found nothing wrong, or thought he had found the trouble. What is more natural than to "try it once and see if it works all right now." During this period, with the jam still on the chain, something will surely give way. This feature could be avoided by still more relay equipment and complication, but we thought it unwise to adopt it, and later worked out another way.

A slipring induction motor with so much secondary resistance that it runs only at 75 to 80 per cent of synchronous speed at one-fourth to one-third rated load has widely different characteristics from a motor in more usual service. It stalls far below rated load, and when stalled it takes somewhat more than rated current, but with usual designs not a great deal more. Therefore, if it is known precisely what the horsepower will be with the chain loaded as heavily as it will ever be, the size of motor and the value of the secondary resistance can be so selected that the motor will be self-limiting in torque and no such relays with contactors, as described above, are necessary at all!

The maximum torque that the motor will exert is not more than double the maximum operating torque for which the job is designed. If something jams, both motors will stall without exerting enough pull on the chain to break or pull down corners. The stalled motors will heat up gradually, but even if the operatives affected—painters, assemblers, unloaders, etc.—forget to push the stop button, as they should be instructed to do whenever the chain stops, the motors will not roast out if the inspector arrives within, say, fifteen or twenty minutes.

If a reasonably sensitive primary

Horsepower Required to Drive Conveyor Chains

THE CONVEYOR chains on which data are given below are of 4-in. pitch, with ⅝-in. pins.

CONVEYOR A. This conveyor is in two sections; the average length per section is 700 ft. The chain has seventeen horizontal, 90-deg. turns and eighteen vertical, 45-deg. turns. One section is driven through a 1½-hp. worm gear speed reducer; the other section has a 1½-hp. spur gear reducer. Each section includes 200 ft. of return chain without load. All hanger rollers and corner rollers are equipped with ball bearings.

With the chain operated at 4 ft. per min. the horsepower output of the two driving motors was:

0.2 hp., approx., when weight of chain and load=13½ lb. per ft.

0.76-0.83, when weight of chain and load=54½ lb. per ft.

These figures include the losses in a silent chain jackshaft and the two speed reducers.

After installing heavy-duty corner rollers and heavier hanger rollers the power requirements dropped to 0.41-0.60 hp. with a weight of 54½ lb. per ft. at 4 ft. per min.

At this speed, measurements showed that the total horsepower output of both motors was 1.64 hp. just as one of the manufacturer's heavy, castiron brackets broke.

Before the installation of improved corner and hanger bearings, the operating tension of the chain under a load of about 50 lb. per ft. was measured with a dynamometer, with these results:

Starting tension, one section, 1,500 lb.; other section, 1,150 lb.

Running tension, one section, 1,200 lb.; other section, 850 lb.

CHAIN B. This chain is 1,100 ft. long with about as many bends as in one section of Chain A. It has a single drive and carries a slightly lighter load. On this chain tests showed:

Starting tension, 700 lb.; running tension, 600 lb.

CHAIN C. This chain is 750 ft. long. Tests have given these results:

Starting tension, 600 lb.; running tension, 400 lb.

relay is used in the motor starter it is generally, although not always, possible to proportion motor size, operating speed, and secondary resistance so that the primary relay will protect the stalled motors against burning out.

I hesitate to go any further into the planning or design of such a drive because the procedure is somewhat involved, requiring the drawing of a Heyland or Behrend diagram. This, in turn, requires either two simple tests on the motor or if, as is generally the case, the motor has not yet been purchased, access to the manufacturer's guarantee, figures of power factor and efficiency at various loads, in order to lay out the diagram.

Another objection to any further explanation of this self-limiting torque protection is this: You cannot plan such a drive for safe operation without secondary relays unless you know fairly closely what horsepower the drive will require. This is very seldom known with any degree of accuracy at all.

I believe that if anyone who is familiar with the circle diagram wishes to follow the matter further he will readily understand it if he will lay out a diagram for the very high rotor resistances which I have specified, and compute a speed-torque curve.

Intelligent planning of a multiple drive of any sort, with or without relays, requires some idea as to the horsepower that will be required to move the chain. Without exception, a novice always overestimates the power required. In the table some data are given on chain tensions and the power required on a number of chains, all having ball-bearing hangers, and ball-bearing roller corners. Caterpillar drives were used on most of them. All of these chains were 4-in. pitch with 5/8-in. pins. These data are not extensive, but they are accurate, so far as they go.

Direct Current Constant-Speed Drives

With d.c. motors the matter becomes even simpler. To produce the large drop in speed with increase of load, we use resistance in series with the armature of a shunt-wound, d.c. motor. The size of motor, compared with the estimated load and per cent drop in speed at full load, should be about the same as specified for an alternating-current application. The relay scheme is simpler, for a single-pole, not a double-pole, instantaneous relay for each motor, is required. It should be placed in the armature circuit. One two-pole or three-pole contactor for jumpering out the instantaneous relays during starting will serve two or three motors respectively.

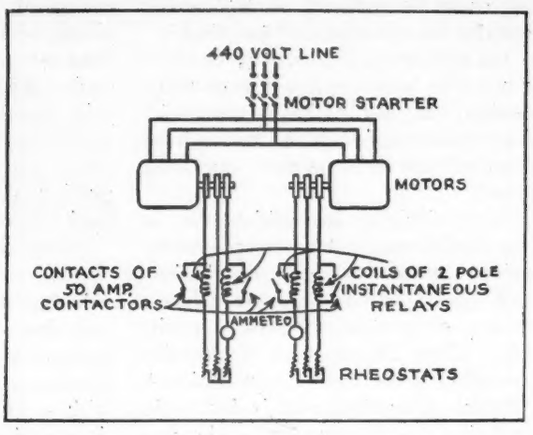


Fig. 2—Main power wiring diagram for two a.c. motors driving a constant-speed conveyor chain.

There is, of course, a definite limit to the torque which such a motor will give with this high armature resistance, but it is of the order of four or five times the maximum operating tension on the chain, so that a self-limiting-torque job is ordinarily impracticable. Four or five times maximum running torque will pull corners down on most jobs.

Variable-Speed Chain Installations

Where it is desired to operate a chain with a number of separate driving motors, using at different times various speeds, say a range of two, three, or four to one, to accommodate a variety of product, seasonal variation of activity, or something of the sort, either a.c. or d.c. motors can be used. However, the advantage of direct current for these applications is overwhelming. Should only alternating current be available I would advise installing a small motor-generator set so that direct current can be used.

At first thought it might seem that the alternating-current layout described above and shown in Figs. 1, 2, and 3 could be made to give considerable speed variation by using a variable secondary resistor. A variable secondary resistor is a fine thing, provided it can be blocked after the final adjustment so that not even a motor inspector with an experimental turn of mind can change it. A variable resistance makes it possible to adjust the speed easily to 75 or 80 per cent of synchronous or no-load motor speed at full load on the chain, if estimates of the operating load are found to be in error when the job is started up. It should *not* be used for anything else.

If an attempt is made to secure any considerable variation in chain speed by this means, difficulties will be experienced—on the one hand, stalling under normal load when low speed is attempted; on the other hand, unequal division of the chain tension and heavy stresses with consequent trouble when an attempt is made to operate the motors too close to synchronous speed in order to speed up the chain.

Successful variable-speed operation with a.c. motors requires a variable-frequency motor-generator set.

However, an a.c.-d.c. motor-generator set costs less, uses a cheaper control scheme with less control wiring.

A direct-current, variable-speed job is simple enough, requiring only armature resistance to give the required drooping speed characteristic to assure load division between any number of drives on the same conveyor, and field control for varying the operating speed of the chain. The motor should be an adjustable-speed, d.c. motor with a shunt field control, such as is used on variable-speed, machine tool drives.

The exact type of motor will depend on the speed range required for the chain; motors having a speed range of 3:1 or 4:1 are fairly common, whereas motors having an extreme speed range of 6:1 are available. In these latter, compensating pole face windings as well as commutating poles are used. Still greater speed ranges are possible by loading the motors far below rated capacity.

One thing must, however, be kept in mind: Many of these adjustable-speed motors are rated on a short-time basis, whereas our application calls for continuous rating. It is necessary, therefore, to find out from the manufacturer how much the rat-

ing must be reduced at the various speeds, for continuous operation.

Inasmuch as a conveyor chain is a more or less constant-torque proposition, the motor size is almost always determined by the horsepower required at the highest operating speed.

If the designer is confident that he can predetermine the horsepower required by the drive at the highest and lowest speeds, he may select a motor with a continuous capacity only 15 to 20 per cent above that necessary to meet the worst load conditions. This allowance is due to the fact that the ventilation of the motor will be poorer than normal, due to reduced speed resulting from the armature resistance used to insure load division. The designer who can predetermine the horsepower necessary to drive a conveyor (unless he has already installed and tested an identical conveyor) is a wizard, indeed. Ordinarily, a motor of twice the estimated horsepower requirement is not too large to purchase, particularly if there is a chance that the load on the chain may be increased later, due to changes in product, or need for increased speed. .

With the direct-current, variable-speed drive the principal matter that requires discussion is the resistance in series with the armature.

If it could be obtained in a simple manner, it would be preferable to use a series resistance in the armature circuit that would give a drop in motor speed, due to armature resistance alone, of close to 20 per cent at the heaviest normal load on the chain at each speed. Preferably, of course, this should be a fixed resistance. However, this is impossible, for the armature current increases in proportion to the chain speed, if the load on the chain is about the same.

Thus, if we reduce the resistance to the minimum practical limit and calculate for a speed drop of 15 per cent due to armature resistance, with normal load on the chain and the slowest chain speed, we will have, with a fixed resistance, 20 per cent drop at double that speed, and 45 per cent drop at triple that speed. Therefore, we would obtain a ratio of chain speed of only about 2:1 with a 3:1 motor, and to obtain a speed ratio of 3:1 on the chain a 6:1-speed motor is needed.

The worst feature is the fact that, when operating above a 2:1-speed ratio on the chain, the actual operating speed of the chain varies with variations in the load rather more than is desirable. This may not be serious, particularly in applications where the load on the chain is fairly uniform, but in other applications where at times every hook is filled, and at other times only one hook in three is filled, such a variation may be serious if a fairly uniform speed is necessary.

Everything considered, it may be said that a fixed resistance should be satisfactory up to and including a 2:1-speed ratio on the chain. For applications involving a fixed armature resistance, the amount of resistance should be figured to give a 15 per cent drop in speed with normal load on the chain and slowest chain speed.

The schematic diagram for such an application is the same as shown in Fig. 4, except that the variable armature resistor *R6* is omitted.

For applications where the chain speed must be varied through a range greater than 2:1, a variable armature resistance as *R6* in Fig. 4 is advisable.

The resistance of this variable armature resistor must increase as that of the field resistor decreases. A simple solution is to use standard, round-plate resistors for both *R6* and *R5*, and mount both on the same shaft but reverse one from the ordinary parallel mounting, as in Fig. 5.

There is no difficulty in selecting from manufacturers' catalogs suitable round-plate field resistors that are near enough to the desired values for practical purposes, and reversing the field control resistor by turning it back to back with respect to the armature resistor. There are, however, two practical objections to this: First, the ever-recurring difficulty of predetermining chain horsepower requirements with sufficient accuracy to permit the selection of proper rheostats beforehand and, second, the fact that the usual setscrew adjustment is not positive enough.

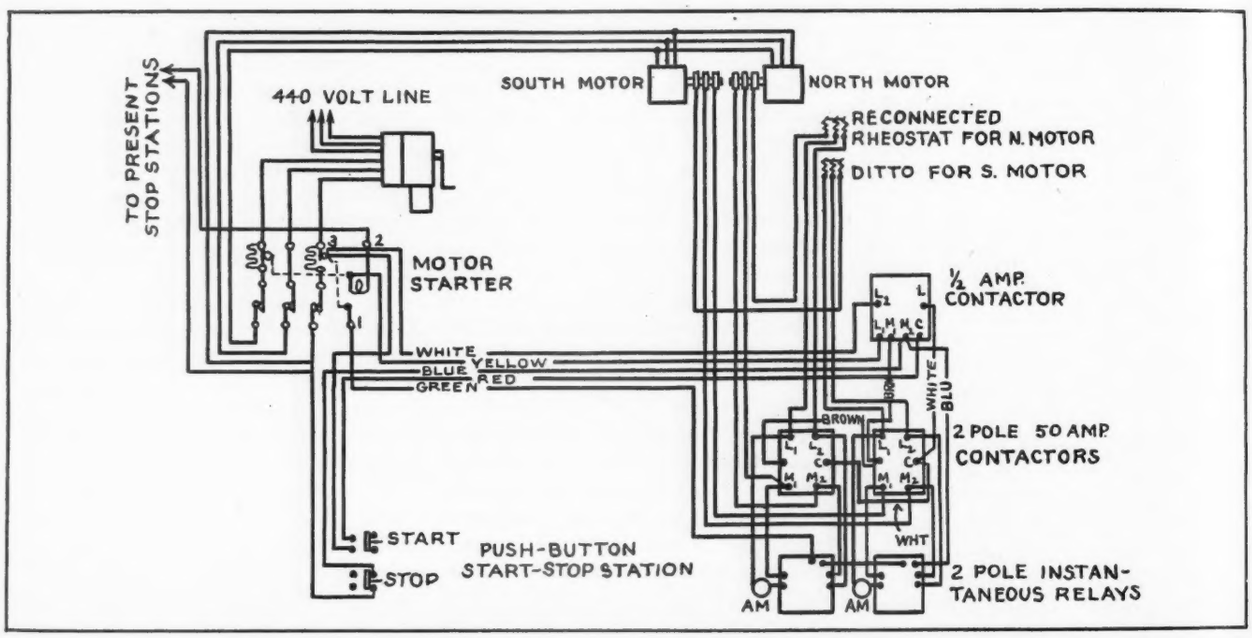


Fig. 3—Complete power and control wiring diagram for two a.c. slipring motors driving one conveyor chain.

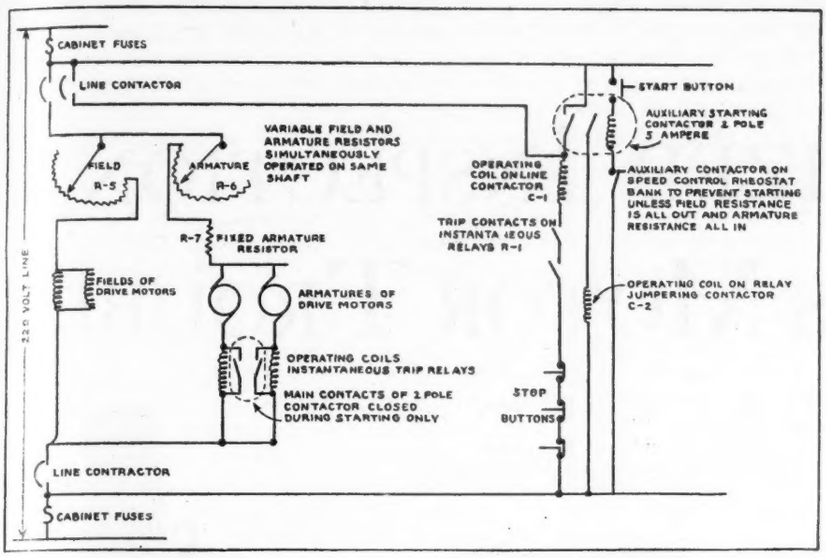

CABINET FUSES
LINE CONTACTOR
START BUTTON
AUXILIARY STARTING CONTACTOR 2 POLE 5 AMPERE
VARIABLE FIELD AND ARMATURE RESISTORS SIMULTANEOUSLY OPERATED ON SAME SHAFT
FIELD R-5
ARMATURE R-6
OPERATING COIL ON LINE CONTACTOR C-1
AUXILIARY CONTACTOR ON SPEED CONTROL RHEOSTAT BANK TO PREVENT STARTING UNLESS FIELD RESISTANCE IS ALL OUT AND ARMATURE RESISTANCE ALL IN
R-7 FIXED ARMATURE RESISTOR
TRIP CONTACTS ON INSTANTANEOUS RELAYS R-1
220 VOLT LINE
FIELDS OF DRIVE MOTORS
ARMATURES OF DRIVE MOTORS
OPERATING COIL ON RELAY JUMPERING CONTACTOR C-2
OPERATING COILS INSTANTANEOUS TRIP RELAYS
MAIN CONTACTS OF 2 POLE CONTACTOR CLOSED DURING STARTING ONLY
STOP BUTTONS
LINE CONTRACTOR
CABINET FUSES

Fig. 4—Schematic wiring diagram of variable-speed, multiple-point conveyor chain drive, using d.c. motors.

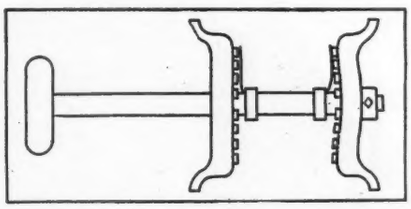


Fig. 5—Round-plate field and armature resistors mounted back to back on one shaft, to facilitate ease of manipulation.

If one armature resistance sweep arm becomes loose on the shaft and falls out of time with the others, some very peculiar troubles will result. If the speed ratio on the chain is high, there will be a wreck when an attempt is made to operate at slow speed in this condition. Even with the instantaneous relays in the armature circuit of each motor, as shown in Fig. 4, there will be a wreck, for these relays must be set high enough to take care of the greater horsepower requirements on the chain at high speeds.

Of course, putting taper pins through the shaft and riveting them over, or tacking with an acetylene torch, will obviate the sweep arm hazard. However, the rheostat then becomes difficult to dismantle in case of need, unless a flexible coupling is used between each plate and the next.

The best suggestion for overcoming the difficulty as to preliminary horsepower estimates is to make the best estimate you can, and then on the basis of test results obtained after the installation goes into service, buy another plate for *R6*.

One caution may not be amiss—in selecting a plate-type resistor for *R6*, obtain one with plenty of current-carrying capacity, for this resistance is all cut in when the motors start; in fact, it acts as a starting resistance.

There are several other methods that might be used, but which have never been tried, so far as I know, to obtain a variable-speed, direct-current drive at several points on a conveyor. One that offers great promise for a drive where two motors only are required involves the use of two motors with 220-volt fields in multiple and 110-volt armatures in series, operated on 220 volts. This arrangement has the great advantage, for some applications, that there would be almost no variation of chain speed with the load on the chain for any given field rheostat setting. The disadvantage is that for any number of motors other than two per drive, special armature windings would be required. Nor is it practicable to extend a drive and add another motor.

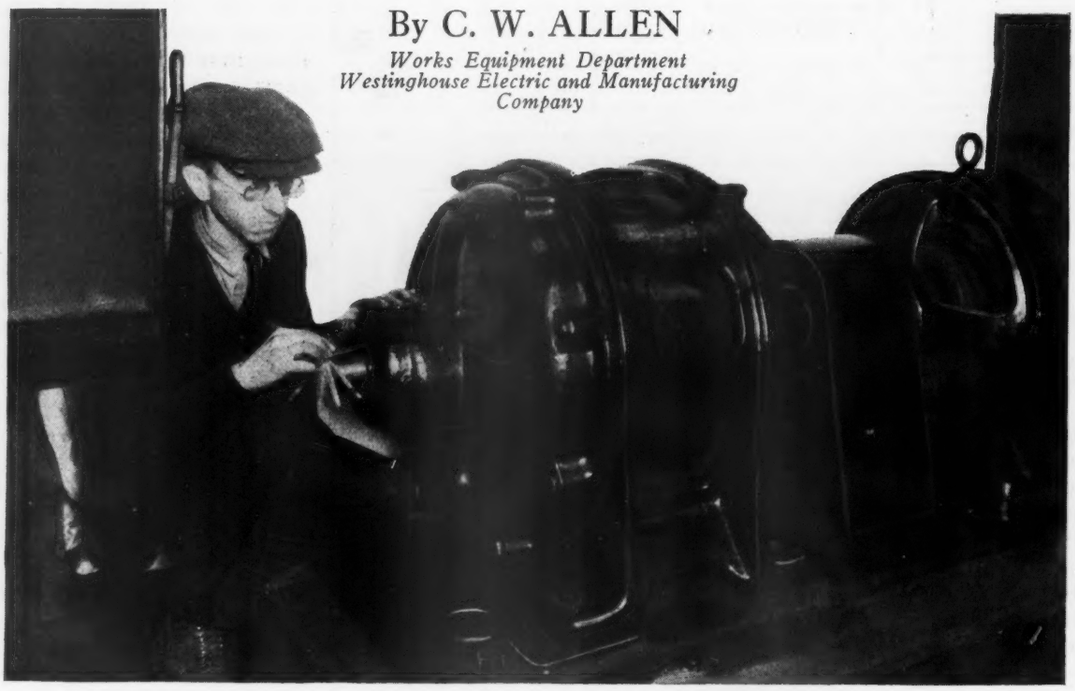
Variable-voltage, or Ward-Leonard control, also offers interesting possibilities. For a direct-current, constant-speed drive, as for an adjustable-speed drive with a speed range of 1½:1 or a little more, but not to exceed 2:1, compound-wound motors have certain advantages. Resistance in series with the armature is unnecessary, but very heavy compounding is required. A motor must be selected that will have a drop in speed of 10 to 20 per cent from no load (hot) to normal operating load at the slowest speed of the chain conveyor.

Photo by "Atlantic Foto Service"

Part of the Atlantic City beachfront and the magnificent display marking the Golden Jubilee of Light.

How ORGANIZED INSPECTION PREVENTS MOTOR TROUBLE

By C. W. ALLEN
Works Equipment Department
Westinghouse Electric and Manufacturing Company



A trouble shooter looking for trouble. Each new installation is examined thoroughly before it is released to the shop or production department.

EVERYONE concerned with the maintenance of any kind of machinery can readily appreciate the advantages of regular inspection of this equipment. Nevertheless there are probably a great many who do not follow a definite plan of inspection and are, therefore, losing many advantages that could be theirs.

In the small shop where there are comparatively few motors in use, it is a rather simple matter to give each motor regular attention, but in larger plants where there are hundreds, or thousands of motors, it becomes very difficult to give proper attention, aside from oiling, to each one.

The purposes of systematic inspection are: First, to check the condition of installations before they are put into service. Second, to detect subsequent conditions that may necessitate changes. Third, to detect and correct troubles as they arise from time to time. In so far as possible, troubles should be corrected as soon as they become evident, instead of waiting until a shutdown has occurred. In other words, apply the proverbial "stitch in time."

In the first place, the whole installation must be correct, if trouble-free operation is to be obtained. Therefore, an inspector is required to examine thoroughly and test each new installation before it is released to the shop or production department. Some of the points to be considered are: Condition of equipment, workmanship, protection required (such as bracket covers on the motor), and operation under full load. This last item is very important, and yet it is not unusual to find motors with reversed series fields, motors running on starting resistance, and so on. The reason usually is that new machines are tried out with light loads, whereas some troubles show up only on full loads.

The inspector should check the operation under all conditions, so that if there is anything wrong, it will show up before production is started on the machine. In some cases there may be doubt as to whether the horsepower of the motor is correct for the machine. In these instances the inspector should measure the power taken by the motor for the heaviest work that will be done on the machine, and report the results of this test to the person in charge of motor application, for his use in supplying the correct motor.

Where motor applications are correct, most of the failures are due directly, or are traceable to, wear. Bearings often wear to such an extent that the rotor rubs the stator or field poles, and causes the winding to

be burned out. Wear of the driven machine may cause the motor to be overloaded and operate at an excessive temperature. Eventually a burnout may result.

It is obvious, then, that keeping motors properly lubricated is very essential to long service without trouble. To meet this requirement in a large plant, the shop should be divided into districts, and an oiler assigned to each district. For economic reasons the district should be large enough to keep the oiler busy, but it should also be small enough to allow him to cover his territory in a period of time consistent with the requirements of the motors. As motors of modern design do not require re-oiling as frequently as do the older types, due to improved construction which prevents leakage of oil, and keeps out dust, the districts having a large number of new motors may be larger than those having a large number of old motors.

In addition to oiling it should be made the oiler's duty to report any cases of overheating of motors, sparking of brushes, or any other troubles that he can readily observe.

In many of the motor-in-base type of machines, the oil cups are not accessible. The oiler should report any conditions of this kind, so that provision for oiling can be made. Where the oil cups cannot be reached, the motor should be removed and each oil cup replaced by a piece of pipe arranged so that the open end will be accessible when the motor is put back in the machine. The oil cup should be placed on the end of the pipe, so that the proper oil level is obtained when the bearing is filled. This or some other similar arrangement will allow the motor to be oiled regularly without difficulty.

Equipment that is properly installed and cared for should give very little trouble, but there will be cases where the work on the machine may be changed, with the possibility of overloading the motor, or the motor may develop defects, such as short circuits or grounds. Also, the voltage of the system may vary and cause motor failures.

It is necessary, then, to have trouble shooters to take care of troubles that arise from time to time. The shop should be divided into districts and a trouble shooter assigned to each district.

It should be the trouble shooter's duty to take care of all trouble on electrical equipment. Minor repairs and replacements of motors or starters, where no new work is required, should be done by him. He should have the authority to secure the service of cranes, trucks, or of laborers when he needs assistance.

When trouble develops on a machine the maitnenance department should be notified by the operator of the machine or by his foreman. Details concerning the procedure of notifying the maintenance department may vary in different plants, but in most instances notice will be given by telephone. In some cases troubles may be reported by tube mail, or by messenger.

In the maintenance department, it should be one person's duty to answer all telephone calls, and in this article this person will be called the trouble clerk. There should be at least two telephones in the department, one to be used for incoming calls from the trouble shooters only. The trouble shooters should be the only ones who know the number of the trouble 'phone, and it should be connected so that no outgoing calls can be made on it. This will prevent congestion on the trouble line and allow the trouble shooters to call the maintenance department without delays due to busy lines.

The trouble shooters should have regular times for calling in. The frequency of such calls will, of course, depend upon the conditions in individual shops. These may also vary in different locations in the same plant. Thus, it may be found that in one division the trouble shooters should call in every half hour. In other departments the calls may be

Breakdown records such as this are kept for future reference in selecting equipment. They indicate the kind of trouble that may be expected with certain types of equipment.

Trouble shooters are assigned jobs from this sheet as they report to the clerk who records all trouble calls.

Electrical Department Motor Trouble Record

Month of Jan. 1928.

	HP	RPM	Tool No.	Machine	Mach. No.	Dept.	Date	Remarks
DC	20	250-1000	6895	Lathe	4256	ME-1	3	Armature burnt out.
DC	½	865	12752	Printing Press	15135	Printing	4	Armature burnt out.
AC	3	1160	14444	Surfacer	9505	I-10	5	Winding burnt out.
AC	¼	1725	33685	Grinder	33859	O-20	5	Worn bearings + Shaft.
AC	¼	1725	33685	Grinder	33859	D-1	6	Worn bearings + Cup [illegible]
DC	25	300-1200	14081	Boring Mill	13986	Y-1	6	Burnt out.
				Drill	24376			Field Coil lead broken

Electrical Department Trouble Report

Power and Motors

Apparatus	Location	Time Received	Time Started	Time Completed	Work Done by	
Motor	A-16	7:20	7:25	7:40	#7	
Line	U-2	7:23	7:30	7:50	12	
Motor	M0	7:35	7:42	8:20	43	
Starter	B-3	7:10	7:40	8:30	7	
[illegible]			2:30	2:45		

Lights

Apparatus	Location	Time Received	Time Started	Time Completed	Work Done by
Rm. Lathe	A-10	7:10	7:20	7:40	#4
Mill Mach	X-3	7:15	7:30	7:50	12
Planer	C-2	8:20	8:30		17

Clock and Semi-Dryers

Apparatus	Location	Time Received	Time Started	Time Completed	Work Done by
Clocks	T-3	9:35	10:00	10:45	#2
Semi-Dry	F-10	10:30	10:45	11:20	#17

Dictaphones and Fans

Apparatus	Location	Time Received	Time Started	Time Completed	Work Done by
Fan	3 M20	1:40	2:00	2:30	#10

Fire Alarms, Police System and Whistles

Apparatus	Location	Time Received	Time Started	Time Completed	Work Done by
Box 152	C-3	2:40	2:45	3:05	#2

Date 2-29 [illegible]

made at longer or shorter intervals, depending upon the nature of the work, or upon the frequency of trouble. This point is to be decided from experience, and may be changed as conditions warrant.

A complete record of all trouble calls should be made by the trouble clerk. This record may be in the form of a diary sheet, as shown. The sheet should show the name of the apparatus requiring attention, the location, the time the call is received, the time the call is given out to the trouble shooter, the time the job is completed, and by whom the work was done.

When a call is received reporting a case of trouble, the trouble clerk notes on the diary sheet the nature of the trouble, the location, and the time the call is received. When a trouble shooter makes his regular call, the trouble clerk assigns any jobs that may appear on the diary sheet. At the same time, the trouble shooter OK's any previous jobs that have been completed. The clerk then makes corresponding entries in the diary sheet. In this way the record is kept up to the minute and serves as a ready and accurate check on the progress of all trouble work.

This plan will be satisfactory in the majority of instances, but occasionally there may be a case of trouble that is especially urgent, and if a trouble shooter cannot be located immediately, it may be necessary for the foreman of the maintenance department to assign one or more other workmen to the job, instead of waiting for the regular trouble shooter to call in.

Although his first duty is to answer calls and correct trouble, the trouble shooter should also hunt trouble. Ordinarily, he will not be kept busy making major repairs and when there are no calls to be answered, he should patrol his district looking for minor troubles. Perhaps he will see a motor that is sparking badly, but is still operating. Upon examination he may find that the brushes are worn, but as yet the commutator is not damaged. A new set of brushes should be installed, and possibly the commutator should be sanded. Production will be delayed while the brushes are being changed, but, on the other hand, if the motor were allowed to run until it "went down" on account of a burned-out armature, much more time would be lost, and a new armature would be required in addition to a set of brushes.

There may be cases where it is not advisable to delay production, even though the motor may be in bad condition. In these cases the motor should be allowed to run until there is an opportunity to repair it. It may be necessary to make repairs on overtime, when the machine is not in operation.

After a trouble shooter has spent considerable time in a department and has kept check on the equipment under his care, he will be familiar with each individual machine, and will know from experience just what service each machine requires. He can then arrange a regular program, exclusive of unexpected happenings, to include systematic inspection of the equipment. By following a regular schedule, drawn up according to requirements, much time and expense can be saved.

To assist in the application and service of motors, a record of each breakdown should be made. This record should include the description of the motor, the location, kind of machine driven, date, and nature of trouble.

A review of these reports from time to time will be helpful in indicating the kind of trouble that occurs most frequently, the kind of motors that give the most trouble, or that require the most attention, and the kind of service that seems to be the most severe. For example, the report may show that considerable bearing trouble is experienced with the motor on a certain machine. A check should then be made to determine whether the machine causes undue strain on the shaft, such as too tight a belt, or whether abrasive dust is present, causing rapid wear, and so on.

Oftentimes when inspecting motors, it will be found that there is a possibility of dust, chips, oil, acid or alkalies getting into the motor and collecting on the winding. It then seems necessary, and it is very common practice, to blow out these foreign materials by compressed air.

The practice of blowing out motors promiscuously is to be discouraged. Although it is true that compressed air will remove dust, it is also true that the compressed air may drive chips or abrasive dust into the winding. Small particles or cuttings may strike the winding with such force that they will cut through the insulation and cause a short circuit by lodging against two adjacent wires.

Systematic inspection makes for safety to operator, safety to machine and material, and economy in maintenance. Although such a system costs something itself, the time and money saved by some plan of efficient inspection will make it worth many times its cost.

One way of preventing undue maintenance. An inspector checks the power input of the motor with the machine under its heaviest load. The results of this test are used in selecting the proper motor for the work.

Maintenance *and* Inspection *of* LEATHER BELTS

CONSIDERING the work that they do, leather belts require surprisingly little care. However, they do have to have some attention, if they are to be expected to render the service which they are capable of giving. The practical rules and principles for belt inspection and maintenance given in this article are based on the practices in vogue in one of the best-known groups of industrial plants, with some additions and revisions by the author.

By J. R. HOPKINS
Chicago Belting Company
Chicago, Ill.

IN order to insure maximum reliability and efficiency of service all belting and drives should be inspected at regular intervals by a competent belt man. A belt card record should be kept, by all means, and should indicate when the inspections should be made. At these times the belt should be examined carefully. Once every two or three months should be sufficient for most belts, but between times the belt man should be on the lookout for trouble from unexpected sources. Dressing the belt and cleaning it can be attended to at the time of regular inspection.

Belt Records

A convenient size of card is 8x5 in., a standard size. The purpose of the card record is to determine whether a belt is the best one for its drive. The merit of one manufacturer's belting compared with another and the amount of care required on a belt should be determined. These data will assist in future purchases and will show how to correct present installations.

Each belt should have its own card. On the card should be spaces for a description of the drive and of the belt, the life of the belt, when it had to be tightened, cleaned, and dressed, and why it failed.

The belt man should watch the record of his belts on these cards to see if any are stretching too rapidly or are requiring too frequent dressings and repairs. This information will help him to correct unsatisfactory conditions. An oak-tanned belt should last for 10 to 20 years on a normal drive and if shorter life than this is being obtained, either the drive or the belt is at fault.

Just before a belt is worn out and taken off, its record should be examined and before putting another belt on the drive it should be decided whether any change in the machine or the type and size of belt can be made to improve conditions.

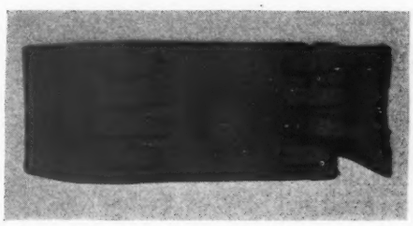
Some of the troubles that may be found when belts are inspected, and the points to be guarded against are as follows:

1. *Edges Start to Open Up*—If the point or feather edge of laps shows the least tendency to open up, the point should be cemented down at once. The best method is: The part of the belt with the opened lap should be put over the pulley. The old cement should first be scraped off the point. Hot cement should then be applied, and the point should be hammered down, the lap resting on the pulley. In this way, the work can be done without removing the belt from the pulley. The belt can be started to run in about 15 min. after cementing.

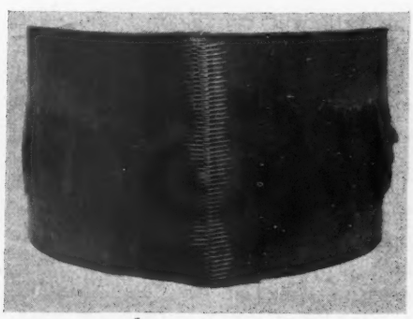
2. *Loose Belts*—A loose belt soon means a burned belt. The friction of the pulley rubbing against the slipping leather soon creates enough heat to burn it. A warning note is given by the belt squeaking, as a leather belt squeals when it slips 3 per cent or more. When this is heard, the machinery should be stopped and the belt tightened to the proper tension. The damage done by slipping can easily be seen by examining the inside of the belt—the leather will be full of fine, cross-wise cracks that eventually will extend through the leather if the belt is allowed to run slack continuously.

3. *Slippage*—Slipping on the pulley may also be caused by the belt being too narrow or too light for the drive. Such a belt should be taken off and the proper size put on before the belt is ruined.

4. *Belt Not Carrying the Load*—Complaints that the belt is not carrying the load may also mean an un-



Careless lacing can injure or ruin the best belt made. The strips of leather used in lacing this 3-in. double belt were too heavy for both the belt and the pulleys on which it ran, resulting in a badly cracked and burned belt.



This 10-in. heavy double belt was used in a cement mill. The cracked surface is belt dressing that has collected dirt and is not scaling off. Note the crooked lacing; this will cause the belt to weave on the pulleys.

dersized belt. Before changing to another size, make sure that the trouble is not due to either a too-oily or a too-dry surface. If a belt is too small for its job more harm than good is done by over-tightening it, as it is likely to slip and its life will be shortened.

5. *Avoiding Fastener Trouble*—Fasteners should be looked at carefully when the belts are inspected. If they shows signs of serious wear, they should be changed at once. A worn fastener may cause the joint to break part way across, and the belt may be ripped from end to end.

6. *Alignment of Pulleys*—Belts can be stretched unevenly or can be torn by catching on nearby machinery or columns if the pulleys get out of line. If it is seen that a belt is running crooked it is best to see whether the pulleys are in line, and if not have this condition corrected as soon as possible. Belts should not be run on flat-face pulleys unless they are shifted belts. Pieces broken from the face, no matter how small, or lack of perfect alignment in the pulleys will quickly cause the belts to run off such pulleys.

7. *Crooked Belts*—Crooked belts can cause the same trouble as badly-aligned pulleys. If the joint in a belt is not made straight when it is put on, the belt will run crooked. A belt that is put on too loose is likely to be pulled crooked at the joint when the power is put on. If such a belt is on flange or step cone pulleys it will soon be ruined. If it is a shifted belt, one edge will stretch until the belt will not stay on the pulleys.

8. *Belts on Step Cone Pulleys*—A belt that is run too loose on step cone pulleys is likely to creep to the next step without being shifted by the operator. In this way it may be run on cones that are not in line. Under these conditions the edge of the belt will rub against the edge of the cone pulley steps. As a result the plies of the belt are separated and the belt is stretched along one edge.

9. *Running on "Crossed Cones"*—The trouble mentioned in paragraph 8 can also be caused by a machine operator who is too lazy to have his belt properly tightened. He finds crossing cones an easy way to make a loose belt tight or a tight belt loose.

10. *Belt Shifters*—Belt shifters that do not throw the belt entirely on or off the loose pulley will cause a belt to stretch unevenly and soon become so crooked that it will be useless. Sometimes the weight of the pole operating the shifter causes it to fall toward the vertical position after the belt has been shifted. This will cause the belt to return partially to its former position, so that it is partly on and partly off the loose pulley.

If the guide rods on the belt shifter are rigid, there will probably be excessive wear along the edge of the belt as it comes in contact with the rods. Some form of roller, or a sleeve on the rod that will rotate as the belt moves along in contact with it, is to be recommended.

11. *Belts That Are Too Wide*—Belts that are too wide for the pulleys will run over one or the other edge of the pulley and are likely to come in contact with some fixed object nearby and be torn. If the pulleys are slightly out of line, the result will be worse.

12. *When Mineral Oil Is Present*—Frequently belts are allowed to run in pits or other places where oil or water has collected or falls on them. This condition should be remedied as it will soon ruin the belt. Leaky steam or water pipes will have the same effect. If the condition cannot be corrected treat the belt regularly with a belt dressing that resists the action of mineral oil.

13. *Effect of Heat*—No heating devices should be put where the heat or fumes from them will strike the belt. The heat brings the oil to the surface where it is easily rubbed off by the pulley. Dry rot can quickly be started in a belt in this way. Belts exposed to heat can often be protected by shields.

14. *When Not in Use*—When a belt is not to be used for any length of time it should either be taken off the pulleys or else suspended from hooks and not allowed to rest on the shafting.

15. *Forcing a Belt to Run Right*—Belts should not be kept on pulleys by the use of guides. If they will not run true, the belt or the drive should be corrected.

Improving the Layout of Drives

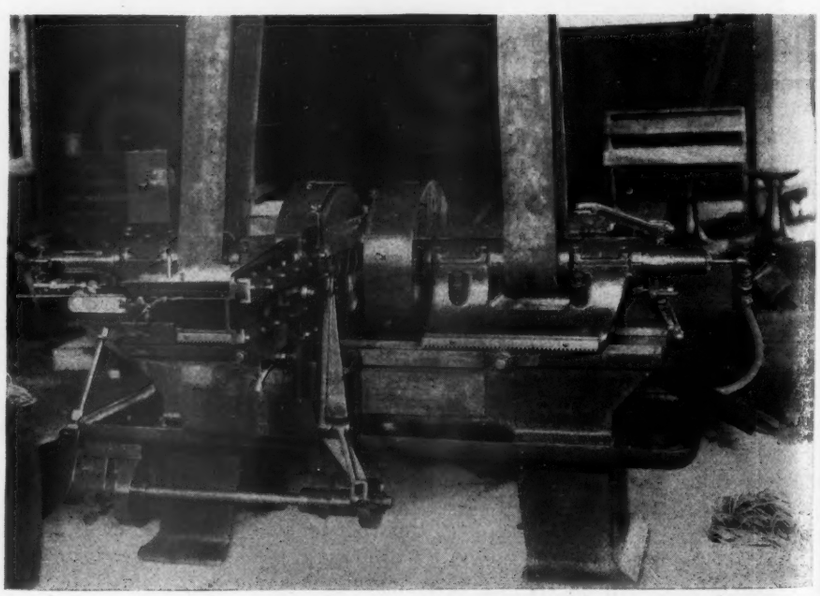
Frequently slight changes in drives can be made that will result in longer life of belting. If bad conditions cannot be changed readily, the attention of the engineering department should be called to them so that they can be avoided in the future.

Some defects in drives that cannot be attended to by the belt man in his regular inspections, but which he should report are:

1. Where it is known that a pulley is too narrow or too small in diameter for the proper size belt, the pulleys should be changed if possible.

2. If possible, machinery driven from overhead shafting should be so arranged that the belt will make an angle from the vertical of not less than 45 deg. Never, unless it is absolutely impossible to avoid it, should the driving and driven pulleys be in the same vertical line.

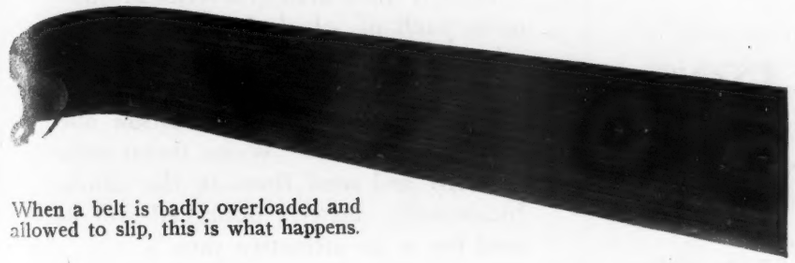
3. The tops of the crowns of pulleys should be in line; otherwise, the belt will be pulled crooked.



The edges of these two belts have been badly cracked as the result of running them on too-narrow pulleys.

4. Machinery should be so placed that the tight strand of the belt will be the bottom strand. This will allow the slack strand to sag down over a greater arc of the pulley and increase the contact.

5. The distances between shafts should be made as great as possible, up to reasonable limits. If the center distance is too great, the belt may flap and be burned or torn. For narrow belts 15 ft. is about the right distance, whereas larger ones can be 25 to 30 ft. apart.



When a belt is badly overloaded and allowed to slip, this is what happens.

6. Idler pulleys should be located about one-quarter of the distance from the driving pulley and should bear against the slack strand.

7. A leather cover on small pulleys helps to prevent slipping and adds life to the belt.

8. Belts should be kept as far away as possible from steam lines, furnaces, boilers, etc. If such locations cannot be avoided, adequate shields should be provided to protect the belts.

Cleaning Belts

Belts should be frequently inspected to see whether they are clean. Belts are injured as much as machinery if they are not kept clean.

If much oil, grease or dirt has collected on them, it should be removed before it causes the belt to slip or the leather to rot. Usually a belt can be cleaned on the pulleys. Oftentimes all that is necessary is to scrape the surface with a wooden block or the smooth edge of a scraper. Powdered chalk or fuller's earth spread over the surface will absorb the surface oil and grease and can then be easily scraped off. Another method is to wash the belt with a cloth soaked in kerosene. A belt should be treated with a high-grade belt dressing after each cleaning.

If there is too much oil or grease in the belt to be removed by these methods, it must be taken off the pulleys and degreased. This is done by immersing it in a tank of gasoline. For this purpose it should be sent to the manufacturer. After degreasing, the belt must be redressed to replace the natural lubricants that were taken out by the gasoline.

The importance of keeping belts free from mineral oil cannot be overestimated. Slipping will be largely eliminated and the mineral oil will not have a chance to injure the belt.

Dressing Belts

A leather belt lasts longer when its fibres are properly lubricated. The lubricants that are put in a belt in the currying process are gradually worked out by its travel around the pulleys and by atmospheric conditions.

If the lubricants are not replaced from time to time, the leather will become dry, it may slip on the pulleys, rotting will begin and its strength will fall. Finally, dry rot ensues and the belt is destroyed. The material used to replace the lubricant that has been lost should be as nearly as possible like the original stuffing compound.

There are many so-called belt dressings of a sticky nature on the market. They are advertised as being capable of stopping belt slippage. They will do so for a time, because many of them contain rosin, pitch or tar, or some substance of a sticky nature. The effect is only temporary. Very soon the dressing collects in lumps and in this form sticks either to the belt or to the pulleys, causing loss of contact.

There are other good dressings on the market which simply restore the lubricants to the leather. Leather properly cleaned and dressed will maintain its adhesive qualities and sticky dressings will not be needed.

Belts should be dressed whenever they are cleaned, or at intervals of six months. The dressing should be put on after the belt has been cleaned and while it is standing still. If it is possible, the belt should be left idle over night so that the dressing can soak in before it is run over the pulleys.

A slight film of grease may be left on the surface of the belt after dressing. This may cause the belt to slip at first; so no load should be put on until this film has been worked into the belt.

Repair of Belts

Most burned, torn or otherwise damaged belts can be repaired. The belt man can do most of this repairing in his own shop.

When a belt is burned or torn it should be taken off the pulleys and taken to the belt shop. The damaged section should be cut out. The rest of the belt should be cleaned and new pieces put in where the cut has been made. The whole belt should then be dressed and it is ready to use again.

When the shifted belt becomes worn or curled on the edges, it should be trimmed before the damage goes too far. The edges should be trimmed back the same amount on both sides.

Belts that have been worn out in parts so much that they cannot be repaired can frequently be cut down to smaller sizes. Belts 10 in. wide or more should have equal amounts cut off on each side when being cut down. This method will leave the backbone mark in the middle of the cut-down section and the belt should stretch the same on each side.

Frequently some pieces in an old belt can be cut out and used for repairing other belts.

A CO-OPERATIVE agreement between the American Standards Association and the United States Bureau of Standards was ratified by Geo. K. Burgess, Director of the Bureau of Standards, and by the Board of Directors of the American Standards Association, July 9, at the Board's first meeting.

Under the terms of the agreement with the Bureau of Standards, the primary effort of the Bureau will be to serve industrial groups having no satisfactory standardization facilities of their own. The American Standards Association will work primarily with those bodies having standardization facilities and will bring together such groups for the formulation of "American standards" representing a true national consensus of approval.

William J. Serrill of the United Gas Improvement Company, Philadelphia, is President of the American Standards Association and Chairman of the Board of Directors. Cloyd M. Chapman is vice-president.

Are You Ready for the Question?

WHO SHALL DO THE WELDING?

Frank Fulleger and George Shipman, since their introduction to readers of INDUSTRIAL ENGINEERING *in May, have brought forth three problems in plant engineering. That these problems are of general interest is indicated by the replies from readers which, in number and length, have been such as to make use of four pages heretofore and require eight in this issue.*

Now another problem has come up. This one is introduced by Shipman, and he finds Fulleger possessed of at least part of the facts to enable him to present pros and cons. The setting this month discloses Shipman and Fulleger in the plant cafeteria, with Fulleger as host.

* * * *

"Better take some of those beans, George, they'll stick to the lining of your stomach."

"Speaking of 'sticking,' Frank, reminds me of what I came to see you about—and that's welding."

"Don't see what I can tell you about welding, George," said Fulleger, "but at any rate let's eat first."

When the food had been tucked away, and pipes were burning, Shipman began: "I don't want any technical information, Frank. All I want you to tell me is: 'Should the average plant do its own welding, or have it done by a contract shop? I'm referring now to welding outside of what's required in production operations'."

"I happen to have been giving that very subject quite some thought," said Frank, "and with your permission I'll give you a brief lecture on the subject."

"Shoot," said George.

So Frank shot: "Seems to me that the product of the plant has something to do with it. If welding can be used for salvage work, as in many metal-working shops, then it can be used for maintenance and repair. But a candy factory, on the other hand, would be limited to repair work.

"Then location—a plant out in the back woods would probably feel entirely unprotected without welding equipment, while one in an industrial center wouldn't need to worry.

"On the average the contract shop, if well managed, can afford to invest more money in welding equipment and the training of operators than can the average plant. On the other hand the installation and instruction services of the companies selling welding equipment go a long way to remedy that deficiency. But actual welding experience counts for a lot, and there the contract shop has the advantage again. Aluminum, cast iron, bronze, steel—it all falls their way.

"But the average plant doesn't see in advance all the jobs it can do by welding. Once it has equipment, however, the number of jobs that can be welded keeps increasing. Then on top of that—"

Here is the fourth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to this month's question also will be published. Write down your opinions and send them to the editor. Incidentally, answers published will be paid for at an attractive rate.

"Hold on, Frank. I've heard enough. I'm down for a 30-minute talk on this subject at the next engineers' meeting and you've given me plenty to think about. I'm asking several plant men how they feel about the subject so I'll not have to rely entirely on my own experience. Thanks a lot."

"So that explains your interest, eh? Well, expressing my ideas hasn't done me any harm. Come on, let's go back to the office. On the way I'll show you one of the prettiest welding jobs you ever saw."

* * * *

It seems to be a habit of George and Frank to quit talking before they have given the entire story. Well, as a matter of fact, they do that intentionally to give you, readers of INDUSTRIAL ENGINEERING, *a chance to complete the story. Let the editor have your discussions within the next three weeks.*

What are the other arguments concerning doing your own maintenance welding or having it done in contract shops?

How about doing part of the welding at home and sending the balance out?

Is welding hard to learn?

How vital is experience?

Readers' answers to previous questions

Who Shall Do the Cleaning?

(Question Presented in August Issue)

MY opinion concerning the question, "Who Shall Do the Cleaning?" as given in the following paragraphs, is written with particular reference to a wood-working plant.

If the plant is large enough each department should do its own cleaning because of the spirit of competition introduced, which is of great value, especially if conditions are noticed and commented upon by the higher-ups. The man in charge of the department will not hesitate to pass the comment along to the man who has charge of the broom, no matter if it is good or bad news.

The men hired for clean-up work should be husky and at the same time intelligent because they should be used for other purposes also. Almost all of the machines are handled by two men, one a feeder and the other a take-off man. The cleaner takes the place of either of these men when he leaves the machine. Another duty of the cleaner is to move heavy trucks. He should receive good wages because of his assistance in production work.

I believe that the maintenance crew should always do its own cleaning after a repair job. The mechanics always have helpers who can do the heavy cleaning, especially while the mechanic is putting on the finishing touches. Moreover, a job after cleaning up always looks better to anybody but especially to the man who did it.

If the management insists upon having the premises clean, which by the way always pays, the skilled or production workers will soon follow in line and keep things clean in their immediate vicinity.

In my opinion Frank is headed in the wrong direction.

—M. B. KRAMER, *Chief Engineer*
El Paso Milling Company, Ltd., El Paso, Texas

"SHOULD plant cleaning be done by each department or by a general cleaning crew?" My experience has been that it is best to have each department do its own.

In some cases, depending on the product manufactured and types of machines, time is allowed before quitting to clean up. If this is not done and the workmen have to stay at their work until quitting time, then the cleaning presents another problem which may be solved by making arrangements with sufficient help to stay longer to do the cleaning.

In case there is a regular cleaning crew in the department they can stay over longer to do the cleaning and can start work later in the morning if total hours are to be kept down.

When there is a general plant cleaning crew there is a tendency to let things lie around and throw refuse around any old place and wait for the cleaning crew to come around and clean it up, which may be the next day.

I firmly believe that the cleaning expenses will be higher in a plant where a general plant cleaning crew does the cleaning than if each department is responsible for its own cleaning. If a workman has to clean up the dirt that he makes he will be careful about the way he litters up the place during the day.

Another disadvantage of the general plant cleaning crew, one easily overlooked, is that in some departments the cleaning will require quite a bit of skill and experience. Take, for example, the shutting down and cleaning of a paper machine. There is a delicate wire to clean, felts have to be cleaned and washed, water has to be left running in certain places and on certain rolls. Then, too, there is the safety side of the work that only the experienced help will be acquainted with. If due precaution is not taken in a

case like this damages amounting to $200 to $300 may result, or trouble may be experienced when starting up again. I am sure that this condition holds true in many lines of industry and there is no one as well equipped as the department help to do the cleaning.

In the absence of a regular cleaning crew, or even if there is one for that matter, I say the maintenance crew should be held responsible for the cleaning up of the dirt made by the overhauling job. This can be accomplished without any extra expense if it is managed right.

Before an overhauling job is completed it will start releasing some of the less important help who may better start cleaning up the dirt instead of watching the rest finish up the job, which will usually be the case. Then, too, there are the tools and the like to clean up when the job is completed. While some are doing this, others can be cleaning up the dirt.

Regarding a skilled worker's attitude toward cleaning up: There will be found a few every now and then who feel that cleaning is beneath them, but I think that the majority of workmen will not object to cleaning up the dirt which they make. In a case where a sufficient number object to cleaning, there is usually enough unskilled help in the department for the purpose.

No, I think Frank is headed in the wrong direction when he is considering a general plant cleaning crew. I believe that if he does employ such a crew he will find his cleaning expenses rising and the different departments no cleaner than they were.

—MARIN PHILLIPS, *Electrical Superintendent*
International Power and Paper Co.
Niagara Falls, N. Y.

Should the Plant Engineering Dept. Have the Right to Question Orders

(Question Presented in the July Issue)

BY all means let the plant engineering department have a voice in the planning of moving the machines in the shop. This department should act as a clearing house for all shifting of machines and shop equipment. The plant engineer should certainly be free to question orders even if he cannot revoke them. By questioning them, instead of following them blindly, he can frequently use his men to much better advantage and can often save space as well as unnecessary moving.

Pride, or the question of precedence, should hardly be considered. But it is reasonable to suppose that, as the plant engineer gets all the requests, or orders, for moving machines, he has a better perspective of the whole situation than is possible for the head of any single department. And after the plant engineer questions an order he should be free to lay the case before the works manager if the matter cannot be amicably arranged with the heads of the departments involved.

The desires of the department heads must be subordinated to the best interests of the plant as a whole. This is not easy when each man considers only his own department. But when a plant engineer keeps his eyes on the whole layout he can do much to harmonize the needs and demands so as to save money for the stockholders. There should be no argument as to his right to question orders even if he follows them afterward.

L. B. COON, *Plant Engineer*
Pioneer Instrument Company

IN plants having an engineering head there will be three groups concerned with the work in the plant having to do with the revision of processes and changes in equipment. The three general groups are the production, mechanical, and electrical divisions.

As a broad principle it is the function of the engineering division to correlate the activities of the plant divisions named above in considering problems of equipment changes. The engineering department must have a man or men versed in the technique of production and capable along mechanical and electrical lines regarding design, operation, and maintenance.

So equipped, the problems should be outlined, and estimates, plans, etc., drawn up in consulation with all divisions. It is the responsibility of the engineering department to understand sympathetically the desires of the production department. Likewise they should be familiar with all new mechanical devices on the market and their availability for reducing the cost of operation as compared with the existing machines which are to be removed or rebuilt. Records of operations and repairs and motor testing data should be consulted to determine whether the existing machine should be moved intact or if it should be rebuilt or even an entirely new unit substituted.

In addition to the factors involved in selecting the proper location for equipment which must be moved from one location to another, or for the additions to existing equipment, there is another important feature. While equipment is being moved is a logical time for overhaul. Many breakdowns and production delays are prevented by such practice. The mechanical device may be dismantled and all wearing parts checked and replaced if worn to the tolerance limit; often incipient cracks or other failures are discovered and repaired. The electrical equipment, such as motors, control devices, and limit switches should be cleaned and adjusted and windings should be painted. The entire machine should be painted after assembly. Such a plan has always paid dividends where it is followed, but it must be thorough.

One instance which came to my attention illustrates the need of thoroughness. A large motor-generator was dismantled, the bearings checked, the felt washers were renewed to prevent the escape of oil from the oil wells, and the windings were cleaned and painted. The machine, which was about ten years old, was placed in service after the work was completed. In a short time severe sparking was noticed and the machine appeared to be over-compounded as the voltage increased with the load. As all adjustments appeared correct the trouble was assumed to be in the contacts of the circuits. The brushholders and all wiring to the compound and interpole windings were removed

and a large amount of fine dust was found between the contact surfaces and they were heavily coated with oxide. All surfaces were draw filed and after the machine was again assembled it operated perfectly. The numerous bad contacts had caused unequal distribution of current between the several brush arms and had served to increase the resistance in the shunt circuit around the series field. One of the shunt field wires was found to be cracked and about ready to open up the shunt field; this was due to fatigue of the copper from vibration.

—ELMER HOUSLEY, *Electrical Superintendent, Aluminum Company of America, Alcoa, Tenn.*

What Shall Be the Maintenance Policy?

(Presented in the May Issue)

THERE are in all manufacturing plants two distinct classifications of costs, namely, Productive Costs and Non-Productive Costs. Each of these contains labor and materials cost. Almost every plant has its own variations of opinion that result in the separation of the various costs and their classification into one or other of the two major classes.

The best rule, to my mind, of determining what is productive and what is non-productive is as follows: All labor and materials that enter into and become a part of the product that is sold are productive; all other labor and materials are non-productive.

Some plants include inspection costs as productive costs, while others consider them non-productive. The former reason out that inspection is part of the necessary means to assure a quality product. The latter argue that if the productive help and the productive foremen performed as they should a quality product would be produced. Therefore, since inspectors and inspection become necessary to compel the productive departments to do their work properly, these inspection costs should appear as a burden expense on production and therefore are non-productive.

There are elements of cost in industry that are varied according to the individual viewpoint of the management in each case, and according to the final classification of costs depend certain "Policies" or "Rules of Shop Procedure."

The one reason why there is any doubt about the "Maintenance Policy" or rather the policy of expense as to Plant Maintenance is because it has always been an impossible problem to develop or maintain any reasonably accurate figures of maintenance department costs. Then, again, maintenance department labor is always out of control; that is, there never seems to be any definite way to keep non-productive labor in step with production.

When a plant is properly organized and costs are properly classified it is an easy problem to develop a method of budget control so that at all times and daily every foreman *KNOWS* exactly when his department is performing properly relative to his budget schedule. A method of this kind so supervises plant operation that it "tells the money where to go" rather than looks over the record of "where the money has gone" and then *"hopes"* that next month will show a better report.

Such a system has, to my knowledge, been in operation for the past five years in one plant employing 1,800 to 2,500 men and has produced a saving in non-productive costs of over $200,000. No extra help was required to operate the system and only five to ten minutes' time is required daily by each foreman to check his department performance and know when his department is performing in line with his budget standards.

The maintenance policy must first be settled as to whether the plant is to be maintained or not. That is, are we to maintain the plant in first class condition, or are we to keep it patched up?

It is a fact that each day's operation of any plant causes some wear of buildings and equipment. When a plant is shut down there is still wear and depreciation. These items cannot be ignored. If honest repair and maintenance are not properly attended to when necessary, then the expense is extra heavy at some future date, due entirely to neglect.

Raw materials are purchased by industry and converted into finished product. Productive labor is the element that produces this change. Therefore, productive labor is the real source of income to the management. The value of plant and equipment, depreciation, and all the various items of overhead expense are included in the final costs, but regardless of all the plant and its equipment and all the supplies and materials on hand no shipments would ever be made without productive labor. Therefore, all shop performance can be measured and controlled on the basis of productive time.

Since productive time is the source of income, then each productive hour must produce enough value to carry its share of productive costs, its share of non-productive costs, and its share of profit. Therefore, a definite relation exists between productive time and non-productive time, and if the non-productive time increases and productive time does not, it follows that profits must be less. This is true of any increase in non-productive costs whether it be an increase in non-productive labor or non-productive supplies. If the non-productive costs increase with no increase in production, then profits must be less.

It follows, therefore, that the plant and equipment must be maintained if the plant is to continue in operation and protected against unnecessary depreciation. The policy, therefore, must be along the line of how this work shall be performed at the least cost to the company.

When work is done by an outside concern it is certain that the finished cost of the work must include the actual cost of labor and materials, the shop overhead costs, and the profit, and in many cases a higher rate per hour is paid to the outside labor than is paid in the maintenance department of the industrial plant.

It is a fact that a great saving in the costs of the plant maintenance is made by doing all such work within the plant by men employed particularly for each branch of the work. I believe any plant of 500 men or over should do all its own repair and maintenance work.

Many industrial plants are guilty of a wrong measurement, so to speak, of just what the maintenance department actually does.

It is nearly always the rule that a large quantity of actual construction work is performed, particularly by the electrical department, carpenter division, and sheet-metal division of most maintenance departments; the work is usually entirely new work and frequently the materials are new, which, if not produced by the maintenance department, would be purchased on the outside. Any such construction work is certainly not maintenance work, yet regardless of how much of such construction work is produced by maintenance department men they are all too frequently viewed as a purely non-productive department.

The maintenance policy should include a system of cost accounts so that purely maintenance work and supplies would be charged against production exactly as they are, and they should be controlled as a percentage of the productive time. That is, each 100 hours of purely productive time would carry, say, for example, 14 hours' maintenance department time; each hour of maintenance department time would carry, say, 22c for departmental supplies. All construction work (not maintenance) should be carried as an entirely separate account, so that the actual true cost of plant maintenance could be shown.

When industrial plants develop a clean-cut, fair, business-like procedure for the measurement of non-productive costs, and then give the shop foreman the necessary facts and a simple measuring stick with which to measure and know his performance, the non-productive costs will be reduced so much that the question "What Shall Be the Maintenance Policy?" will change to "What Shall Be the Cost-Office Policy?."

Every industry has its group of "foremen" who really are the plant management; each is a specialist in his own particular department and field of work. Teach these men the principles of business procedure, and give them the rules to work by, and each one will take pride in the efficient result of his own department; collectively there is an efficient plant.

A plant manager's duty is to organize and co-ordinate his organization, to teach them the principles of that particular business, and show them the costs; to develop and lay down a plan of plant performance to produce results, and the actual application of his rules and methods to the individual details in the plant are taken care of by the foremen. Thus the foremen are actually the management, and how well or how poorly they manage is shown by the figures as compiled by the cost office.

—H. M. Benton, *Plant Engineer*
Pratt & Whitney Company
Hartford, Conn.

MAINTENANCE work should be done within the plant:

1. When the plant manufactures a product or products that require the services of, and is large enough to maintain the services of a mechanical, electrical and building repair crew of 20 men and upward, the makeup of the crew consisting of millwrights, machinists, pipe-fitters, electrical workers, blacksmiths, concrete men, tinsmiths, painters, and specialists such as welders, pattern makers and motor winders.

2. When a plant—no matter what size—is situated in an out-of-the-way location, remote from repair shops, and where transportation facilities are poor.

Maintenance work should be let to contract shops:

1. When the plant is small, and employs few hands.

2. When the plant is situated in close proximity to repair shops capable of handling all kinds of repairs at a reasonable cost.

3. When the nature of the product does not cause frequent breakdowns.

4. Where the repair crew consists mainly of a millwright and an electrical repair man.

5. Where changes are made, either in the buildings or equipment, that require the hiring of extra skilled labor for short periods.

Maintenance work should be split between contract and inside work:

1. When the plant requires the constant attention of millwrights, but where pipe and steam fitting, electrical repairs, welding, tinsmithing, painting, etc., are infrequent.

2. Where the overhead in maintaining stores of various kinds added to the cost of repairs is greater than the cost by contract for certain lines of repairs.

3. Where the amount of work expected or proved by experience does not warrant the outlay for equipment—welding, for instance.

4. Where changes or additions in the existing buildings and equipment require the hiring of extra skilled mechanics for short periods.

The question of where to draw the line in regard to whether maintenance work shall be done within the plant or by contract depends on (in addition to the above):

1. The size of the plant.

2. The number of employees.

3. The number of machines.

4. The period of operation.

In some cases it will cost more to get work done in contract shops and sometimes it will cost less. Instances where work done by contract shops is cheaper are:

1. Where overtime must be given the regular repair crew.

2. Where the regular crew is not large enough and new men have to be broken in to the work.

3. Where the work is of such nature that the plant crew is not familiar with it.

4. Where the plant facilities are not adequate to cope with the work, and proper machinery must be rented.

The limitations of orders for contract work should depend upon:

1. The nature of the work.

2. The length of time part of the plant will be idle.

3. The difference in cost between contract work and inside work, and the time saved, if any.

In issuing any order for contract work, the matter should be thoroughly gone into and discussed by the various heads of the departments affected.

The amount of unnecessary work done by the maintenance crew will depend entirely on the department heads, or the plant manager. Plant maintenance, like insurance, is a necessary evil, and although most managers realize the necessity for insurance, not all of them realize the need of a maintenance crew. Some managers do not realize that the maintenance crew is one form of insurance, and that when the plant is operating at its maximum capacity and the maintenance crew is idle they have the ideal condition. They are not satisfied unless all the maintenance crew are working overtime.

It stands to reason that when there are no repairs, no material is being used, and from the writer's experience, the costs of labor and material about equal one another when the crew is busy.

Case after case can be cited where various members of the maintenance crew spend all of their idle moments—so to speak—in repairing automobiles, etc., for the plant manager and superintendents, where they, and not the company, derive the benefit. The plant manager who is alive will see that enough spare parts are kept on hand, and when a breakdown occurs, repairs can be made in the shortest possible time, and the part or parts damaged or broken can be repaired or duplicated while the plant is operating at full capacity. In this way, the crew is kept comparatively busy on work that can hardly be called non-productive.

The management should have gone into conference with all who were vitally interested, and explained the need of the new policy. It is much easier for the head of a department to explain matters to the personnel of his department when he is acquainted with the facts, and greater cooperation can be had when the confidence of the department is gained.

H. E. Stafford, *Electrical Engineer*
Port Arthur, Ont.

"WHAT shall be the maintenance policy," of course, requires different answers for different plants, and conditions change so that it is sometimes necessary to change the policy of any plant. The following answers are therefore quite specific and will illustrate the conditions and the policies adopted for pipe and electrical maintenance in a large automobile factory.

(1) Under what conditions should all maintenance work be done within the plant?

Upon whether the maintenance work is made up of a few large, well-defined jobs, or a large number of small jobs carrying with them a considerable element of trouble shooting depends the answer. The large job, such for instance as replacing a long run of pipe or a burned out cable, can, with the exception of tying the new work in, be contracted outside, but if the work consists in locating the trouble as well as repairing it, such as a faulty trap or a burned contactor in a starter, requiring considerable time to locate and a short time to fix, then it can best be handled by inside maintenance men. If part or all the construction work is done by the maintenance department, then there will be available men for doing the occasional large maintenance jobs, and under these conditions all the maintenance work should be done by the maintenance department.

(2) When should all of it be let to contract shops?

We have never experienced a condition under which all the maintenance work should be contracted, because the multitude of small jobs, emergency calls, etc., would have to be done on a time and material basis anyway and competitive estimates would be impracticable.

(3) When should it be split, and how?

It is not desirable to carry enough maintenance men as such to perform the occasional heavy repair job, although these jobs can usually be done by men borrowed from the construction gang if it happens that such a gang be employed at the time. If such borrowed men are not available then the maintenance work should be split, doing the small jobs and emergency work with inside men and contracting the big jobs which can be made competitive.

(4) Does it cost more to get the work done in contract shops?

Job for job we find it costs more to contract the work than to do it with inside men.

(5) Should there be a limit on the amount of the order that the maintenance department may place?

Yes. A limit is and should be placed on the amount permissible on a maintenance order so as to bring to the attention of the management any items of unusual anticipated expense. This is usually controlled by a budget.

(6) Is much unnecessary work done by the maintenance department just because the men are available?

The man in charge of maintenance should keep himself informed as to what his responsibilities are, for it is quite possible that the management is relying on him for some phase of the maintenance program of which he is not fully aware. It may be that maintenance orders are received by the maintenance department properly executed by persons in other divisions of the plant and carrying all the earmarks of authority to proceed with them. The maintenance man may be working on the assumption that all orders received have been properly scrutinized before coming to him, the unnecessary ones weeded out, and that his sole function is to execute those orders with the maximum of speed and the minimum of cost. The chances are ten to one that the scrutiny has at times been superficial and that some of the orders originated at the

bench or machine, in which case the following may happen: The workman wants some change made and makes out an order for the foreman to sign. The order looks reasonable to the foreman and as he has confidence in this particular workman, he signs it without further investigation because he is very busy on something else at the moment. The order goes to the general foreman who looks at it casually, discovers the name of his most competent foreman on it, and signs it because he feels that the order is necessary, coming from this particular man. In like manner the document gathers signatures and momentum as it passes through the organization, and finally reaches the maintenance department marked "Rush" without a single man except the workman who originated it having considered the real necessity for doing this work.

Everyone was relying upon his trusted assistant from the top clear down to the bottom, which provided an open channel through which the company's money could be spent with no other audit for the necessity of it than that of the man who originated it. This is apt to happen in any plant. Don't be too sure it never happens in yours. It certainly will happen unless the man at the top either gets first-hand information on every order himself or is successful in getting his assistants to do so. This condition frequently results in jobs being done which are unwise and unnecessary. However, these jobs are performed because of a faulty system of scrutinizing orders rather than because there happen to be available men on the payroll, which is demonstrated by the fact that unless the orders are halted before reaching the maintenance department they will surely be contracted in outside shops at an increase in cost even though no inside men are available for doing the work.

The total money spent by the maintenance department is determined by two factors: the cost of each job; and the number of jobs. If, then, the policy of contracting outside does not result in a decrease in number of orders on account of a closer scrutiny of orders, it may actually increase the total cost by increasing the per-job cost. Even though the work is contracted the purchase orders should be written and the work inspected by the maintenance department. This all means that the maintenance man should have a breadth of vision to enable him to apply the scheme suggested by the management without getting into the pitfalls which surround it.

(7) Should the management have explained to Frank why the new policy was adopted? If so, would Frank have had to spend much time explaining to the men?

By all means, "Yes." Frank is a thinking man and should be taken into the confidence of the management to that extent. It would increase his interest by rendering the policy intelligent to him. Frank would find little necessity for explaining to his men, but where explanation was necessary he could put punch into it because he has firsthand information and is not blindly carrying out an order in which he does not believe.

—C. C. WILCOX, *Supt. Power Division, The Studebaker Corporation, South Bend, Ind.*

FEW plants have a sufficiently accurate cost system on maintenance work to make the choice of a policy much more than a carefully considered and intelligent opinion and as such the writer presents the following.

Very large plants running 24 hours a day and 5 to 7 days per week, such as blast furnaces, steel mills, paper mills, etc., in which there are comparatively few large producing units, but comprising on the whole a large amount of equipment, and in which interruption of service to one unit represents a substantial loss of output, are obliged to carry on their own maintenance work. These have sufficient work to occupy the attention of a competent master mechanic with good foremen for the different trades and can produce man-hours of production comparable with contract work.

Manufacture of routine replacement equipment parts depends largely on the price at which the manufacturer of the original apparatus will supply them, but in estimating the cost of making them in the works repair shop full allowance should be made for overhead, rental of building and machinery, light, heat, and power as well as labor, otherwise an excessive organization may be built up, burdening the equipment account with machinery not directly increasing production and dividing the attention of the supervisory force which could more profitably be concentrated on the condition and upkeep of the main process machinery. Over-maintenance and aimless experimenting may be checked by seeing that correct returns of all time and material are made against job orders describing the work and proper scrutiny of these accounts by the management.

The medium-sized plant can most profitably split its repair and maintenance work between its own and outside shops. The repair force should be kept down to that which can make the necessary replacement and repairs to machinery in the shutdown time available and only sufficient routine part manufacturing work carried on to keep the men busy between breakdowns or repair jobs. The master mechanic in such plants can devote any spare time to a personal inspection of machinery, equipment, buildings, etc., very profitably.

All work such as painting, building construction, pattern making, and foundry work, manufacture of machine parts, etc., on which exact specifications can be issued and competitive prices obtained, should be done by contract, but overtime work on a cost plus basis by outside contractors is unsatisfactory as labor efficiency is low and quality of work usually poor.

The very small plant is almost compelled to send out all its repair work and will find it profitable to arrange for such service with one local shop so that one or two of the men will become familiar with the equipment and give better and quicker service.

The foregoing are maintenance problems pure and simple, but many maintenance department difficulties are really faults of the management, i.e., there is no definite policy or clear understanding of the work and the director of maintenance may make his decision correctly in the light of his information and be blamed because it was not in accord with facts not furnished him. In such cases a limit to the expense to be

incurred without specific authorization is really a protection.

By far the better plan is the setting up of a schedule of all maintenance work aside from minor routine repairs, have this discussed at the periodical meetings of department heads or foremen, and, if no budget system is operated, approved by the management. In this way probably the most good will be done and everyone will be satisfied he has had his say on the subject, although usually the best talker gets more than his share of the benefits.

Another of these difficulties is explanation of new policies by the management to the workers. Where the management has shown that it is telling the truth and has obtained the confidence of the workmen, almost any results in cooperation and assistance are possible. But in too many cases explanations or statements do not correspond with actions and the workman has been fooled so often he is quite sceptical, entirely aside from the radicals (nowadays comparatively few) who are always ready to put the worst construction on everything. Such actions are sheer dumbness on the part of the management, as usually it would be just as easy to tell the truth in the first place or a little foresight would forstall the granting of privileges which are withdrawn shortly after, as the exasperation of the men and the loss of prestige by the management cause far greater losses in labor efficiency than was gained by the original grant of the privilege or the money saved by its withdrawal.

—H. D. FISHER, *Plant Engineer*
New Haven Pulp & Board Co.
New Haven, Conn.

THE maintenance department of any plant should be large enough to take care of the work which develops. It can be done cheaper in the plant provided the right type of men and executive control are provided. It can be done quicker and furnish better service in the production department, eliminating the necessity of lengthy shut-downs. Maintenance can be carried on more efficiently by having the proper inspection service on all apparatus. Inspection service cannot be done by outside contract shops because they are not familiar with local conditions.

Should a sudden rush of maintenance work develop, and the crew on hand be unable to handle it, the employment of a contract shop for that particular work is recommended.

Where the plant can develop its own maintenance program slowly and carefully by selecting good men this policy should be maintained. There are certain cases in maintenance work where there is not sufficient employment for certain trades. The average maintenance department consists of machinists, steam fitters, carpenters, blacksmiths, yardmen and in some cases painters, masons, motor repair men, tinsmiths, plumbers, etc. There may be cases, however, where some factories may not have enough brickwork or painting to keep these trades busy all the time. In this case the contract shop is the only source to turn to and is recommended by the writer rather than hiring in a few of these tradesmen for any specific job.

I believe that it costs more to have work done in contract shops than in the factory's own plant provided this work is of the nature which the maintenance department is fitted to handle.

Under such conditions the maintenance men can underbid the contract shop every time, for several reasons. First, they know conditions of buildings, machinery, equipment, operation, and the factory itself. They can have closer supervision by the department heads. Their overhead expense should not be any greater than that of the contract shop, and in the average factory they are not allowed to charge a profit, where the contract shop must do so.

The maintenance department should be limited in the size of order that should be placed with an outside concern or in its own department. The limit will vary with the type of work handled and the maintenance organization. If the man in charge of this department has not the confidence of the owners of the business and sufficient judgment to be able to handle orders of more than $100 he ought not have the job. I believe that the limit should be placed between $250 and $500 and it is my experience that in emergency work repairs must be handled and the expenditure discussed after the job is completed. In each case the owners should be notified as to the difficulties involved.

Under the present prices for material and labor, only small jobs will run much less than $100. The replacement of a motor and compensator often runs into more money than this. The department, however, should operate on a budget set up at the first of each year. New appropriations should be obtained for contemplated improvements and should have the closest scrutiny by the directors of the company.

I do not believe that any maintenance department will carry on unnecessary work just because the men are available. The average maintenance department keeps its organization at a minimum consistent with the amount of work on hand and it has been my experience that there is enough emergency work and necessary jobs to be handled without looking around for something to do.

All work handled by the maintenance department should be requisitioned by various foremen, approved by superintendents, and in some cases approved by the owners before going to the shop. The work orders should be checked by the department heads to see that everything is being handled efficiently. The job should be billed at its completion so that the foreman, superintendent or owner should know what each job costs. By having this system of ordering and billing it is easy to eliminate the possibility of unnecessary work.

The management should explain to the person in question why any new policy is adopted so that he may cooperate to the fullest extent and also have an insight into the difficulties or policies that might be adopted from time to time. Unless all of the executives of any business are taken into the confidence of the management and shown why such policies are necessary, it is sometimes impossible to obtain their point of view.

K. D. HAMILTON, *Mechanical Department*
George E. Keith Company, Brockton, Mass.

First Aids in TRANSFORMER

By D. R. DALZELL

Transformer Division
Central Station Department
General Electric Company
Pittsfield, Mass.

AFTER a transformer has been installed, with the usual precautions to see that it is in the best of operative condition and it is supplying the load without any untoward event, it might be assumed that no further attention need be paid to it. Continuity of service, however, depends not only upon the original condition of the transformer, but also upon its subsequent regular inspection and maintenance. These duties will work no hardship on the plant personnel, as only a few points are involved and which may be readily checked.

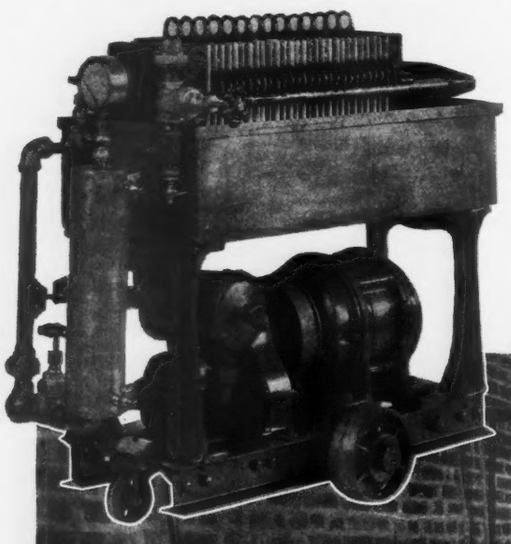
Moisture in the Oil

Moisture is the arch-enemy of a transformer because the dielectric strength of its insulation may be seriously impaired thereby. Fortunately, even minute quantities of moisture in transformer oil may be detected by dielectric tests. The proper method of sampling and testing transformer oil was discussed in an article on Transformer Installation which appeared in the February, 1929, issue of INDUSTRIAL ENGINEERING.

When a transformer is first placed in service the test value of the oil should be 22,000 volts or higher, and oil in service should not be allowed to fall below about 75 per cent of this value, or 16,500 volts. After a transformer is first placed in service it is well to make a check on the oil every week for the first month of operation, simply to be sure that the transformer and oil are absolutely dry.

If a transformer was thoroughly dry when originally installed and it is of the type having an expansion tank or conservator so that the main tank is completely filled with oil, the chance of moisture entering the transformer proper is practically negligible. The only point at which moisture can enter is into the conservator, where it will condense and settle to the bottom, whence it can be drawn off readily from a valve provided for that purpose.

In a so-called open-type transformer, however, there is space above the oil level which communicates with the outside air through breathers or ventilators. If such a transformer, located outdoors, is fully loaded during the day, the oil will expand and force air out of the air space. If most of the load is removed at night, the oil will contract in cooling and breathe in cool air from the outside. Under certain



One type of transformer oil dryer and filter press equipped with air bell for testing suction piping.

How a chemical company isolates its transformers and arranges for inspection. Valves facilitate the taking of oil samples.

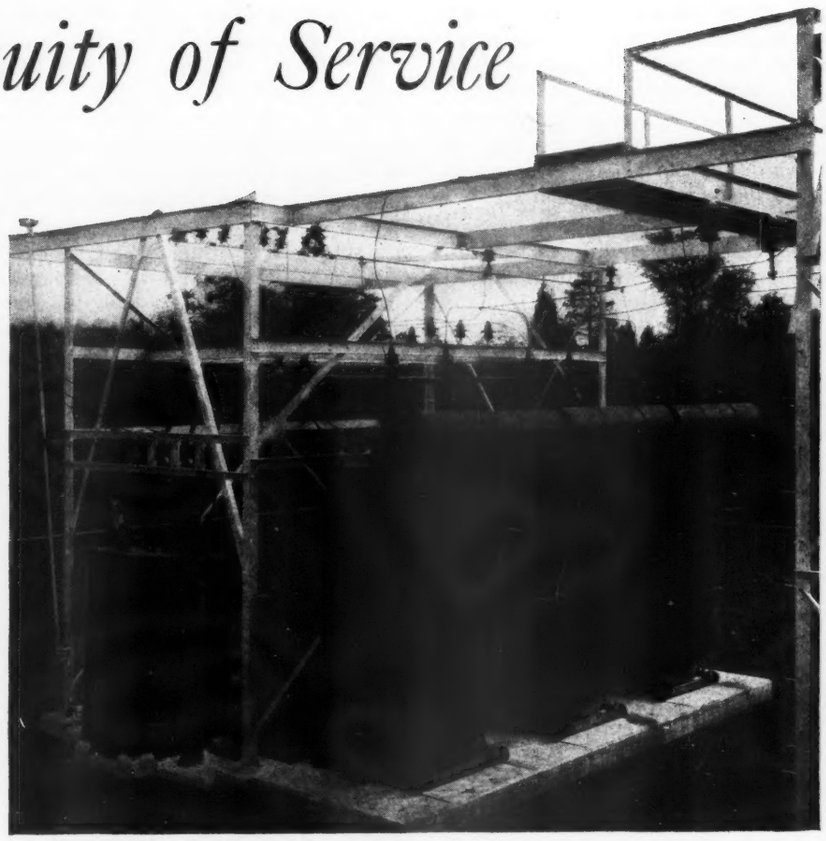
MAINTENANCE

for Continuity of Service

conditions moisture may condense inside of the transformer and drop into the oil.

This moisture may or may not be dispelled from the oil in the form of vapor and escape to the outside with the resumption of the load, so that it is entirely possible that this absorption of moisture may sooner or later cause trouble. Therefore, samples of the bottom oil should be taken every six months and tested to determine if the dielectric strength is up to standard.

It is also possible that the moisture may collect in the form of free water at some point, such as the terminal boards or the top of the core, where it will not cause trouble immediately. It may not mix with the entire body of oil, and yet the dielectric strength of oil samples may be up to standard. However, under these circumstances traces of moisture or rust will usually appear on the underside of the manhole cover, and inspection at regular intervals will reveal such a condition.



Expansion tanks or conservators prevent moisture from settling to the bottom of the main tank. It condenses herein and is drawn off from a valve provided for that purpose.

If Moisture Is Found

Except under the most unfavorable conditions, free ventilation of the air space should relieve any accumulation of moisture. More ventilators can be obtained from the manufacturer or they may be made up from ordinary pipe fittings and metal screen, and added around the tank rim or cover. An alternate method is to raise the manhole cover slightly, at the same time providing adequate protection from dirt and the weather.

Any free water found at the bottom of a transformer tank when taking oil samples should, of course, be drawn off. If the dielectric strength of the bottom oil is below standard while that of the top oil is high, a filter press or centrifuge should be arranged to draw oil from the bottom of the transformer and discharge it into the top. If the upper oil is poor while the lower oil is good, the purifying will be expedited by reversing the flow of oil.

In order to avoid the possibility of trouble from air bubbles in the oil, it is preferable, though not absolutely necessary, to remove the transformer from service while the oil is being purified. Purifying should be continued until samples of both the top and bottom oil test satisfactorily. Twenty-four hours after the purifying is stopped, another set of oil tests should be made to be sure that the transformer proper is dry and is not throwing off moisture into the oil.

If the purification of the oil and further ventilation of the transformer does not effect a permanent remedy the trouble may be due to a leak in the cover or in some of the joints at the top of the transformer, which should, of course, be stopped. If moisture has been in the transformer for a long time, it will be safer to dry the transformer core and windings as well as the oil. Usually the best method except for very small, low-voltage transformers (below 150 kva. and below 6,000 volts) is the short-circuit method in oil, as discussed in the forementioned article on Transformer Installation.

Sludging of Oil

When subjected to continuous heating, and in the presence of oxygen and a catalyst such as hot copper, transformer oil will gradually oxidize and form what is known as sludge. In general the higher the

temperature to which the oil is subjected the more rapidly sludge will form. It may be present in solution and is accompanied by acidity and darkening of the oil or, in worse cases, may appear in the form of a solid precipitate. The latter will be deposited upon all horizontal surfaces in a transformer and will tend to clog the oil ducts and further increase the temperature of the windings. The effect is, therefore, cumulative, and if allowed to persist may result in the weakening of insulation and consequent failure of the transformer.

When properly designed, the conservator or expansion tank prevents air from coming into contact with hot oil, and in transformers so equipped the possibility of sludging is thereby practically eliminated.

If traces of sludge are found in an open-type transformer when taking samples of oil for dielectric tests it is nearly always an indication of excessive temperature, the cause of which should be determined as quickly as possible. If sludge is thickly deposited on the core and coils the latter should be removed from the tank and washed with clean oil under pressure.

Solid sludge can be removed from oil by means of a filter press or centrifuge. The sludge in solution cannot be removed in this way, however, and it may be sufficient to cause a recurrence of the precipitation. In this event, it is usually best to provide new oil.

Loading and Temperature

Practically all transformers are designed in accordance with the Standards of the American Institute of Electrical Engineers. They are continuous rated; in other words, they will deliver the kva. output marked on the nameplate without a temperature rise in excess of 55 deg. C. above the maximum cooling air temperature of 40 deg. C. (or an ingoing water temperature of 25 deg. C. if water cooled). Although a transformer will usually carry a heavy overload for a few minutes and a slight overload for a longer time, or even continuously, nevertheless it is to the best interest of the plant engineer to keep the load within the kva. rating of the transformer. If the windings are allowed to operate at excessive temperatures, deterioration and failure of the insulation will eventually result.

As already explained, excessive temperatures of either windings or oil, if maintained in an open-type transformer without a conservator, will cause serious sludging of the oil.

It is reasonable to expect that if the surrounding air temperature is low, a transformer will successfully deliver load in excess of its rated output. A conservative application of this principle allows the output of a continuous-rated transformer to be increased 1 per cent for each degree that the temperature of the surrounding air is less than 30 deg. C. Conversely, for each degree that the temperature of the air is greater than 40 deg. C., the output should be decreased by 2 per cent. The margin of 10 degrees between these two limiting values of air temperature is established by conservative operating practice. If loading is determined with only the oil and air temperatures as guides, caution is necessary because the winding temperature varies with the load much more rapidly than the oil.

When a transformer is first installed and is operating at full load, it is well to record the rise in temperature of the top oil above the surrounding air. If at any later time this temperature rise should become more than 5 deg. C. greater than when the transformer was first placed in service under the same load conditions, the cause should be determined.

In general the oil temperature of a self-cooled transformer with a conservator should not be allowed to exceed 80 deg. C. and without a conservator 75 deg. C.; for a water-cooled transformer these limits should be 65 deg. C. and 60 deg. C. with and without a conservator, respectively.

By keeping a record of oil and air temperatures and analyzing them in conjunction with the percentage of load, the operator is provided with a check on the condition of his transformer and burnouts and breakdowns can be avoided.

Cleaning and Painting

Any deposits of dust or soot should be wiped from the porcelains of bushings, in order to maintain their full flash-over voltage. Such a cleaning should be done at a time when the transformer can be removed from service. When painting a transformer, care should be taken to prevent paint from splashing on the porcelain.

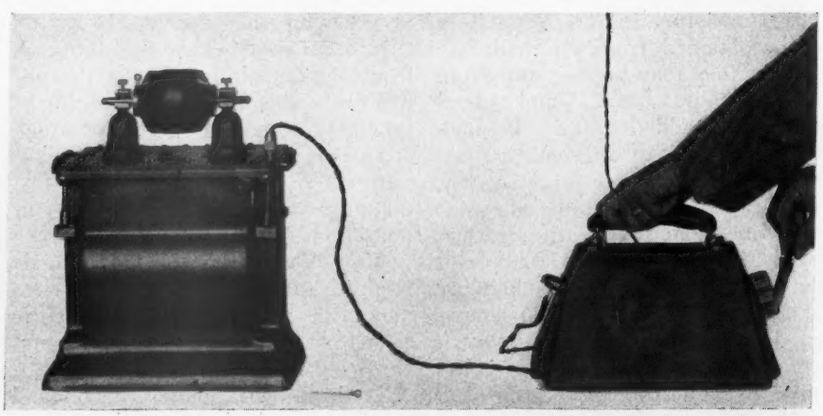
A transformer should be painted as often as conditions warrant, not only for the sake of appearance, but also to prevent corrosion.

So far as heat dissipation is concerned, either a light or dark color of paint is satisfactory. A dark-colored paint is generally used because it will not discolor as readily as a lighter finish. However, if a large transformer is located in a warm climate, receiving the direct rays from the sun and it is fully loaded during the day, a light color is sometimes used, as it will reflect rather than absorb heat from the sun. A paint with a metallic base such as aluminum is not quite as efficient with respect to heat radiation as a non-metallic paint, although it can be used outdoors with about the same results as with dark-colored paint.

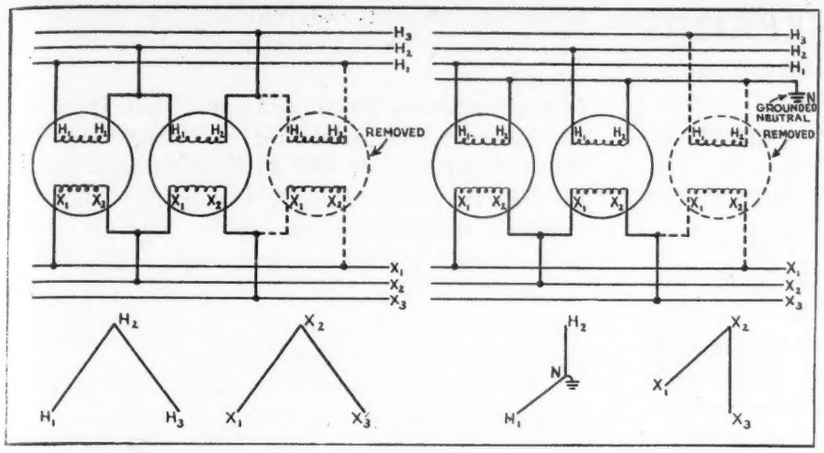
Under operating conditions, the kind of paint used will not affect the oil temperature more than one or two degrees Centigrade.

Stopping Oil Leaks

Slight leakage or seepage of oil may occur in service, and though insufficient to lower the oil level appreciably over a long period of time, it may accumulate dust and disfigure



It is no longer necessary to transport oil samples great distances to be tested. The chance of contamination enroute is eliminated by the use of portable testing sets as shown.



(*Left*) Connections and voltage diagrams of a delta-delta bank of single-phase subtractive transformers with one transformer removed. (*Right*) Similar diagram for a Y-delta bank. Note that the neutral of the bank and also the high-voltage system must be grounded solidly.

the transformer. If such a leak in a threaded joint cannot be stopped by tightening the joint, lower the oil level when there is an opportunity and open the joint. The condition of the threads should be checked, both male and female, and if necessary they should be re-tapped, particularly those on any short nipples that might have been distorted by the heat when welded to the tank. Bakelite varnish or shellac can be used as a filler, but they will tend to shrink after the solvent has evaporated.

A leak in a gasketed joint can sometimes be remedied by tightening the joint, but if this is not effective the joint must be remade with a new gasket. Joints that are subject to oil pressure are usually made with composition cork gaskets. Hard gaskets may be used effectively where both metal surfaces are very smooth, while a softer grade should be used between unmachined surfaces.

Joints in a gasket should be made with the ends scarfed for about two inches so that when overlapped they will fit perfectly. Angle pieces should be used at sharp corners. Bakelite varnish should be applied to both metal surfaces after they have been cleaned thoroughly and freed from scale, also to both sides of the gasket and throughout joints in the gasket. The most effective method of making a large joint such as between a tank and cover is to apply bakelite varnish to the tank band and to one side of the gasket and install the latter with weights on the top to hold it firmly for several hours until the varnish has set. The gasket will then remain in place while its upper surface, as well as the underside of the cover, are being coated and the joint made. Varnish should also be applied to the inner surface of the gasket which is in contact with oil. The gasket should be compressed to about half of its original thickness, tightening the bolts uniformly by a small amount one after the other, going around the circumference several times. Allow several hours for air to escape from the cork and tighten again to about one-third of the original thickness. For a very long joint even a third tightening is desirable.

The exact point of a leak in a welded joint can be determined after cleaning the surface with gasoline by covering it with powdered chalk, against which the leak will show up as a dark spot.

The best way to repair a pin-hole or a very small crack in a weld is to peen it, first working up the metal around the hole with a blunt chisel. A round-nosed hammer should be used for the finishing blow, which, if carefully done, will seal the leak.

For larger leaks, welding, brazing, or even soldering are effective if the cracks are first grooved out and carefully cleaned, and the oil lowered about two feet below the point to be welded. The cover should be removed in order to prevent the accumulation of explosive gas mixtures or, if this is impracticable, carbon-dioxide or nitrogen gas should be introduced to fill the space above the oil level.

In repairing a small leak through a casting it is seldom possible to peen, but good results can be obtained by drilling a hole through the casting at the point of the leak, tapping it and inserting a pipe plug, making the threads tight with bakelite varnish.

If three single-phase transformers in a bank are connected in delta on both the high- and low-voltage sides, a damaged unit can be removed, leaving the other two units connected in open delta to carry the load. The current in these remaining units will now be 30 deg. out of phase with the voltage, so that they will operate with an internal power factor of 86.7 per cent, while their total output instead of being two-thirds of the output of the original three-phase bank will be reduced to 86.7 per cent of two-thirds capacity, or 58 per cent of the original bank capacity.

In an open-delta bank supplying a three-phase load balanced equally on all phases it will be found that the voltage regulation—that is, the difference between the voltage at no load and the voltage at full load—will be greater than for the closed-delta bank and also will be unbalanced for the three phases.

If one phase of a delta-delta connected three-phase transformer is damaged, it also can be operated in open delta if special precautions are taken. If the transformer is of the core type, that is, having three core legs with windings around each leg, the entire damaged winding must be removed. If only the insulation between coils of the same winding is damaged, the remainder being intact, the winding should be open-circuited at a number of the cross connections between coils to keep to a low value the voltage to ground throughout the undamaged portion of that winding.

If the transformer is of the shell-type having an independent magnetic circuit for each of the three phases, the damaged winding, or the intact portions of the damaged winding, must be carefully short-circuited in order to prevent further damage.

Emergency service can be obtained also with a bank of transformers connected in Y on the high-voltage side and delta on the low-voltage side, if both the neutral of the Y and the neutral of the system are solidly grounded. The neutral of the transformer bank and that of the system should preferably be tied together through the ground or neutral wire. The output of the bank, however, will be reduced to 58 per cent of the original total capacity, and the regulation will be unbalanced as with the open-delta bank. Due to the fact that the remaining transformers are electrostatically unbalanced, however, such operation should be resorted to only in extremely urgent cases.

INDUSTRIAL ENGINEERING

Covering the Plant Engineering Function in Industry

L. C. MORROW, *Editor*

Chicago, September, 1929

Yes, We All Pay "Fire Tax"

FIRE Prevention Week is with us again. The dates are October 6 to 12, inclusive. It seems that there should be no necessity for setting aside a certain week during which to give attention to the prevention of fires, yet such is human nature that practice has proved the value of so doing.

"Fire losses are in effect a tax on every man, woman, and child in the United States," says President Hoover. "This is one case where the 'taxpayers,' entirely by their own efforts, can reduce the rate." And that is true. The insurance companies distribute the premium money that they collect to persons who lose by fire. Of course the manufacturer includes the cost of insurance in his overhead when figuring the cost of his product and setting the selling price. Thus the cost of fires is distributed over the entire population, since practically everything we have to do with is insured at all times. To secure lower insurance rates it is necessary to reduce loss by fire.

To industrial plants there is the danger of permanent as well as temporary loss. According to the National Fire Protection Association, of 100 manufacturing or mercantile plants that burn, 43 do not resume operations, 14 have definite and extensive reductions in credit rating, 17 fail to issue a financial statement at all, and 26 register large losses in business.

Industrial plants can do two things to protect themselves: Remove causes for fire, so far as they can be discovered; and maintain ample protective and alarm equipment and fire-fighting personnel. Selection of equipment and training of personnel are important. Not just anyone can take on the fire job—he must be fitted for the job. Study on the part of the man at the head and continual education and training of the fire fighters are essential.

Small Plants to Contribute to Next Census of Manufactures

EVERY other year the United States government takes a census of manufactures. The census is invaluable in providing statistics on which to base production and distribution programs. It is strong or weak in proportion to the number of manufacturers contributing to the information secured. Heretofore the amount of information collected from small plants has been meagre.

Secretary of Commerce Lamont has appointed an Advisory Committee on Manufactures under the chairmanship of Col. L. S. Horner, president of the Niles-Bement-Pond Company. The committee is composed of twenty-five men prominent in business and industrial activities. Thus it is assured that the data to be collected and the tabulations to be made will be of the greatest practical value to manufacturers.

The advisory committee has recommended a complete census, one covering all manufacturing plants regardless of size. The smaller plants will be covered by the population enumerators, while the larger plants will be approached by the Division of Manufactures of the Census Bureau direct.

Heretofore there has been collected from the small plants little information concerning the amount and value of their output. The forthcoming visit of the census taker may on that account be somewhat of an adventure to them. They should not be alarmed or resentful; should, on the other hand, be as helpful as they can in the work of building up what is in effect a worthwhile business guide.

Large plants, and plants of medium size have had census experience, which means that they will be glad to cooperate with the Department of Commerce again. Probably they will also voluntarily undertake to explain to their smaller brothers the advantages of the census.

Housekeeping for Trouble-Free Components

IN SPITE of the meager attention given to certain phases of the plant's electrical system, it is remarkable how infrequent service interruptions occur. This is true especially of that portion of the system from the point of utilization back to the substation. It indicates that either the distribution system with its supplemental equipment is not the weakest link in the chain, or that good housekeeping had something to do about it in the beginning.

Good housekeeping pre-supposes an ample supply of material in the initial installation. Beyond this point, as a rule, all further interest ceases.

Take the motor and its control as a unit. In most plants it receives as much attention as the production machine. It receives periodical inspections, and is kept clean and well lubricated. It undergoes load tests at stated intervals during which its accelerating periods are observed. Vicious starting and pull-in torques are eliminated. At

other intervals, it is taken to the electrical repair shop where it is equipped with new parts and painted before being placed in service again.

Lighting devices receive almost similar attention unless there is no appreciation of the value of lighting as a working tool. Servicing the equipment at the point of utilization is good housekeeping, but what about the intervening portion? Somehow or other, sight is lost of the elements that contribute to the success of the motor, and the lighting as well.

Is the conduit that sustains the cable, or the distribution circuit carrying the current of less importance than the device it energizes? Then, there are the oil switches and other protective devices, safety valves in fact. The absence of trouble is no proof that an immediate failure is not approaching. It might mean that the unexpected is about to occur, and if it does happen don't be too sure about your housekeeping methods. Don't play the ends against the middle.

For Properly-Trained Welders Only

NEW INDUSTRIAL arts create new hazards. This statement is strikingly emphasized when welding is used as a medium for production, maintenance and repair.

In the days of the blacksmith, the predecessor of the welding operator, hazards were of his own making and purely of a local character, but with the tool of today they are far reaching in their effect upon the operator. These hazards are classified as physiological and mechanical, or in simpler terms, health hazards and accident hazards.

Among the former are those created by injurious light rays and by fumes and gases produced by the action of the heat evolved during the process upon the material welded, while those of the latter are the result of carelessness on the part of the operator and in most cases are preventable.

Some companies even go so far as to examine their welders at short intervals to determine their physical condition and provide preventive measures against poisoning—others take the viewpoint that the operator presents a more difficult problem to handle than the welding apparatus, and if anyone is burned it will not be the welder. Naturally every poker player is concerned about his own chips, but operators can do a lot toward making the game as safe for others as for themselves.

Statistics show that burns resulting from carelessness form the majority of injuries to persons in the welding trade, without discounting the possibilities of poisoning. A properly trained operator will protect his fellow workman by chalking each job in a way that everyone will understand the warning and thereby prevent another burn. It's a simple request to make and a gesture easily accomplished and worth the effort. If disregarded, statistics will remain the same and welding will retain its hazards. Properly trained operators will try to change both. Are you one?

Let the Safety Congress Help You Reduce Accidents

FROM the days when unlucky members of the earliest races slipped down mountainsides, fell out of trees, or had their skulls cracked by poorly-aimed stones thrown by an excited companion at some enemy, accidents have played an important part in human destinies. Until recent years, accident prevention was largely an individual matter. If a person were careful enough he could probably avoid serious mishaps; if he, or someone else, were careless he was injured—perhaps killed.

As with many other activities, preventing accidents has become more than a matter for each individual to handle as he sees fit. Although the responsibility of each person for safeguarding his own welfare and that of others has not been eliminated, the problem has grown far beyond the point where individual efforts are effective. The increasing congestion of our cities, the upbuilding of huge plants crowded with machinery, the tempo and every condition of modern life make the highly-organized thought and action of many persons needed to keep the yearly totals of injuries and deaths and the money loss from accidents from reaching appalling figures—bad as they are now.

The National Safety Council is the great center of thought and activity in accident prevention work. Therefore, the Eighteenth Annual Safety Congress to be held in Chicago, September 30 to October 4, should be of much more than passing interest to everyone who is even remotely concerned with safety work.

The papers and discussions that will be presented at the meetings of the various sections, which cover a wide range of industrial and other activities, should be a source of information and inspiration that no plant engineer can afford to overlook. For upon the plant engineer and his assistants lies the unescapable responsibility of seeing that injury hazards in industrial plants are reduced to the minimum.

Modernization

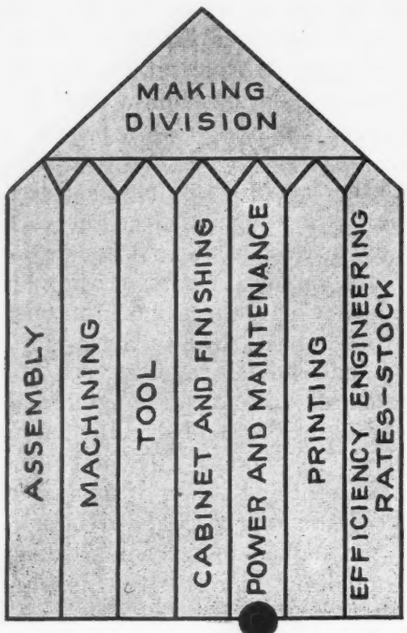
in its relation to the Plant Engineering Function is the theme of the next (October) issue.

NATIONAL CASH REGISTER

Organization for Plant Engineering

By E. D. SMITH

Maintenance Engineer
National Cash Register Company
Dayton, Ohio



Organization chart of "Making" Division, showing the place of the Power and Maintenance Department.

PLANT engineering as a function is common to all industry. Organization for performing the function, however, differs in individual plants, as has been shown by preceding articles published in INDUSTRIAL ENGINEERING.* In the plant of the National Cash Register Company the function of plant engineering is centralized in the Power and Maintenance department of the "Making" division of the works. The head of the power and maintenance department is the "Maintenance Engineer," and the head of the making division is the "Plant Superintendent." The accompanying chart shows the organization of the making division and indicates the relation of the power and maintenance department to the division as a whole. Details of the departments other than power and maintenance have been omitted to avoid confusion.

It is seen by reference to the chart that there are seven sub-divisions of the power and maintenance section:

Construction
Electrical
Plumbing and Millwrighting
Power House
Plant Inspection
Outside and Landscape
Factory Layout

The averages of personnel in these sub-divisions are as follows:

Construction: 1 construction engineer; 2 assistant engineers; from 0 to 20 men.

Electrical: 1 foreman; 1 assistant foreman; 15 to 40 men.

Plumbing and Millwrighting: 1 foreman; 3 assistant foremen; 40 to 150 men.

Power House: 1 foreman; 1 assistant foreman; 3 watch engineers; 26 men.

Plant Inspection: 1 foreman; 5 assistant foremen; 125 to 150 men, including watchmen, janitors, cleaners.

Outside and Landscape: 1 foreman; 20 to 40 men.

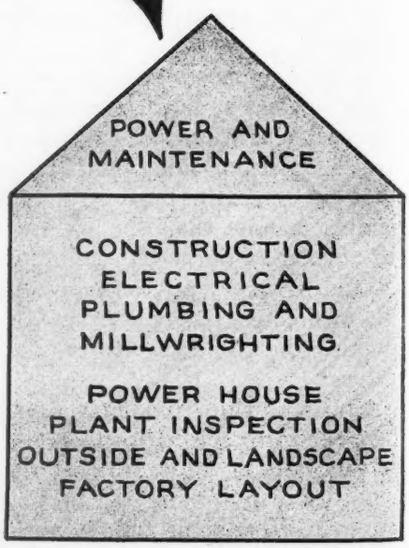
Factory Layout: 1 head; 5 to 20 men.

This group does the plant engineering for a factory composed of 23 buildings, totaling 27,000,000 cu. ft. and containing 53 acres of floor space; having 1,800 motors totaling 12,512 horsepower, 4,800 machines in the mechanical equipment; and 7,655 employees.

Breakdown of duties of the seven sub-divisions of the power and maintenance department is as follows:

Construction: All work in connection with preparation of plans, specifications, and drawings for new buildings, major and minor alterations, and changes. Supervision of building maintenance, floor loading, and similar details. Heating and ventilating problems, and the selection of heating and ventilating equipment center between the head of this sub-division and the maintenance engineer.

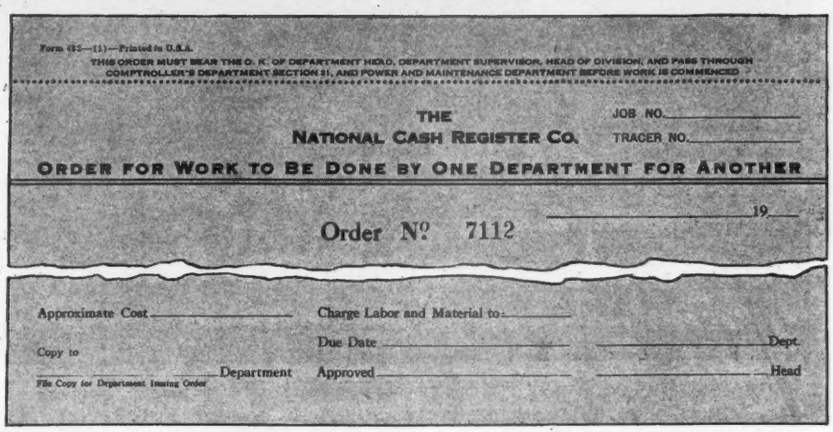
Electrical: Handles all electrical work throughout the factory, office and power plant. Includes work having to do with new construction, underground feeder systems, supply and feeder lines to various buildings, motors and related electrical equip-



*"How We Are Organized for Maintenance and Plant Housekeeping," W. G. Ross, Chief Engineer, The United States Aluminum Company, New Kensington, Pa., April, 1929, and "Organization for Plant Operation and Maintenance" (organization of E. J. Brach & Sons, Chicago), July, 1929.

Millwright Shop.

Ten copies of this Work Order are distributed.



Form 62—(1)—Printed in U.S.A.

THIS ORDER MUST BEAR THE O. K. OF DEPARTMENT HEAD, DEPARTMENT SUPERVISOR, HEAD OF DIVISION, AND PASS THROUGH COMPTROLLER'S DEPARTMENT SECTION 31, AND POWER AND MAINTENANCE DEPARTMENT BEFORE WORK IS COMMENCED

THE NATIONAL CASH REGISTER CO.

JOB NO. _____

TRACER NO. _____

ORDER FOR WORK TO BE DONE BY ONE DEPARTMENT FOR ANOTHER

_____ 19__

Order No. 7112

Approximate Cost _____ Charge Labor and Material to: _____

Copy to _____ Department Due Date _____ _____ Dept.

File Copy for Department Issuing Order Approved _____ _____ Head

ment. All orders for electrical equipment must pass through this department.

Plumbing and Millwrighting: All plumbing, heating, steam-fitting, piping, and millwright work, including the installation of all new factory equipment and the moving of old equipment. This department specifies such power transmission equipment as speed reducers, pulleys, belting, and so on, except when part of the machines themselves, in which case the efficiency engineering department has control. All orders, of course, go through the routine of approval by head of department and are placed through the purchasing department.

Power Plant: This sub-division handles all problems relating to power plant operation and assists in the preparation of plans for changes and alterations to be made within the power house. A detailed power cost sheet is prepared monthly by the comptroller's department, and the power plant organization is held strictly accountable for costs. The power plant group handles its own maintenance, except the larger items.

Plant Inspection: Housekeeping is the province of this sub-division. The work includes fire protection, watch service, sweeping, mopping, window washing, emergency cleaning, messenger service, cleaning of lavatories and toilet equipment, renovating, cleaning and replacing 4,000 cuspidors each night. It includes, also, such cleaning of the outsides of the buildings as is done.

Outside and Landscape: Perhaps this group is so termed for want of a better name. It has charge of general upkeep of plant grounds. It is equipped to, and handles, such work as placing and repairing concrete floors, foundations for machinery, and excavating. It maintains the shrubbery, trees, and lawns. Moreover, it operates, on company property, a 50-acre garden, the products of which are used in the company dining rooms.

Factory Layout: This sub-division prepares the plans for changes in equipment layout, whether made necessary by variation in output or because of changes in methods. It co-operates with the various manufacturing departments in planning changes in equipment or methods. Complete layouts of equipment and methods are made by this department before substantial moves of any kind are made. This department also lays out all conveyor equipment and supervises its installation. (The actual work of installing is done by the millwright group.)

Woodworking Maintenance and Painting

On account of our well organized Woodworking Department, maintained for output purposes, it is advantageous to have the woodworking maintenance done by the carpenters of this group. It has been quite con-

venient, also, to tie on the painting crew, because a large part of its work consists of following up the carpenters.

It will be seen that there is much work done by one department for another. To insure systematic procedure and to place responsibility the work order illustrated is used. Ten copies are made, of which the original is delivered to the supervisor of the department of origin. The comptroller gets two copies, the superintendent three, and the power and maintenance division four. It happens that most frequently the order originates with a foreman; it must be OK'd by his supervisor and approved by the head of the making division. Each order blank bears these instructions: "This order must bear the OK's of department head, department supervisor, head of division, and pass through comptroller's department and power and maintenance department before work is commenced."

Our policies concerning plant engineering are well defined and, in carrying them out, responsibility is clearly fixed. I do not want to leave the impression, however, that there is no flexibility in our system, particularly as concerns the selection and purchase of equipment. As a matter of fact there is extensive co-operation, not only within the power and maintenance group itself, but between that group and the research, efficiency engineering, and purchasing departments.

Electrical Shop.

Shop of Plumbing Department.

National Electric Exposition

ENTERING as it does into all phases of economical and social life, the light and power industry will demonstrate at the National Electrical Exposition to be held in Grand Central Palace, New York City, during the week of Oct. 7, 1929, motivating ideas and goals transcending purely business and mercenary considerations by presenting that which is practical and beneficial to those whom it would serve.

From an educational point of view the exposition will go far afield in stimulating the well defined policy of those within the electrical industry who are cooperating with educational institutions in cultivating a well developed, well educated and practical product for the future mechanical, technical and executive positions within the industry.

Electrical refrigeration will have an important place in the exposition from a practical and educational viewpoint, as well as other interesting, educational and commercially beneficial exhibits.

Fred W. Payne and Charles F. Roth, with offices in Grand Central Palace, New York, are the managers of the exposition.

"Light's Golden Jubilee," commemorating the fiftieth anniversary of the invention of the incandescent lamp, designed as a world-wide expression of gratitude to Thomas A. Edison, will make its initial bow during the progress of the exposition, when floodlights of golden hue will mark the pathways to the exposition.

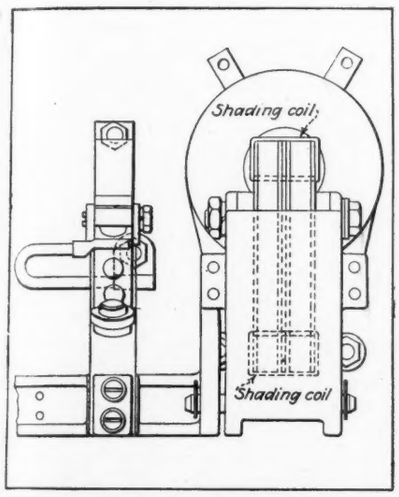
President Hoover has accepted the honorary chairmanship and will head the general committee of "Light's Golden Jubilee" celebration. The Governors of five states, the mayors of 26 cities and thirteen foreign countries will issue proclamations urging appropriate celebrations on October 21st, simultaneously with the grand celebrations in New York City and at the home of Henry Ford in Dearborn, Michigan.

Features that distinguish

ALTERNATING-CURRENT MAGNETS

By H. D. JAMES

Consulting Control Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.



THE DIAGRAM above shows the front view of a three-pole a.c. magnetic contactor, of which only one pole is detailed here. This contactor is not equipped with magnetic blowout.

* * * *

THE performance of a.c. magnets is more complicated than that of d.c. magnets and most of the energy taken from the line is absorbed by the iron and appears as heat in the iron circuit.

One of the important differences between the two types of magnets is that the line voltage applied to a d.c. magnet is balanced by the product of the resistance of the coil and the square of the current. The line voltage applied to an a.c. magnet is balanced by two internal voltages at right angles to each other: namely,

(*a*) The voltage required to send the current through the resistance of the coil, which is usually small.

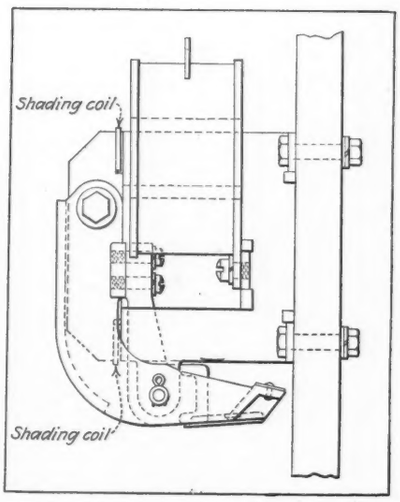
(*b*) The countervoltage generated in the coil by the alternating flux in the iron circuit.

Since (*a*) is small and at right angles to (*b*), it has very little effect and for practical purposes we can consider that the magnet windings must develop a countervoltage equal to the line voltage. This countervoltage is equal to a constant multiplied by the number of turns in the coil, the frequency of the current, and the total magnetism in the iron.

If we consider that the frequency of the circuit remains constant and that the number of turns in the coil also remains the same, we find that the current in the coil changes with different air gaps in order to keep the total magnetism the same. It is very interesting to put an ammeter in series with a magnet coil and then gradually change the air gap. It will be found that the current increases directly with an increase in the air gap up to the point where the leakage flux becomes a factor of decided importance.

When a magnetic contactor is in the open position and the coil is connected to the line, we get a current very much in excess of that taken by the contactor when it is closed. We speak of this current as the "open gap" current, and of the latter as the "closed gap" current. If the contactor is opened and closed frequently, the average current through the magnet is increased, due to the excessive current taken at the time of closing. Frequent operation, therefore, tends to overheat the magnet coil; if the operation is very rapid, the coil may be burned out.

When a magnetic contactor is in the closed position, the current in the coil is easily affected by the air gaps in the different parts of the iron circuit. These gaps are very small, so that a slight change in any one of them may materially increase the magnetizing current. Overheating is sometimes caused by the mechanical parts of the magnet becoming disarranged so that some of the air gaps are increased.



A SIDE VIEW of the magnet. It will be noted that two shading coils are used: one at the upper and the other at the lower air gap. The purpose of the shading coils is explained in the text.

* * * *

The heating in the magnet coil is made up of two elements:

1. The ohmic loss, which is equal to the number of ohms in the coil multiplied by the square of the current. This is the only heat that is developed in the coil itself.

2. The heat due to the iron loss of the magnet is communicated to the coil and contributes materially to its heating. Any increase in the magnet current increases the heating as the square of this current, so that the heating increases much more rapidly than the current.

It is often desirable to know what will be the effect if a magnet coil is operated on a voltage or frequency which differs from that for which it was designed. If we will remember that the countervoltage generated by the coil is proportional to the number of turns multiplied by the frequency and the total magnetic flux, we can readily understand that if the voltage is increased and the number of turns remains constant, either the

frequency or the magnetism must be increased sufficiently to balance the line voltage.

Sometimes the line voltage is considerably above the value for which the magnet was designed. If it were a d.c. magnet the heating would be due only to the square of the current in the coil, but in an a.c. magnet the total magnetism and, therefore, the iron loss increase directly in proportion to the increase in voltage. If the iron is being worked near its saturation point, a 20 per cent increase in voltage may cause a 50 per cent increase in the total magnetizing current.

This not only increases the temperature directly, but the iron loss goes up rapidly and adds its temperature to the coil windings. The solution of this problem consists in obtaining a coil with enough additional turns to compensate for the increase in voltage so that the magnetism will not be increased.

If a coil is designed for 60-cycle operation and is used on 25 cycles the voltage must be reduced in the same ratio as the frequency. Ordinarily, a 550-volt, 60-cycle coil will operate satisfactorily on 220 volts at 25 cycles, or at 440 volts on 50-cycle current.

Direct-current coils can be used on voltages higher than normal by inserting resistance in the coil circuit, but this procedure is not satisfactory for a.c. magnets as the current taken when the magnet is open is so much in excess of the current when it is closed that a resistance suitable for lowering the voltage on the coil with the magnet closed will not permit enough current to flow to close the magnet when it is open.

The flux in an a.c. magnet passes through zero twice at every cycle. This causes the magnet alternately to pull and release the load in rapid succession, so that it makes a loud chattering noise. To avoid this, shading coils are used. A shading coil is a short-circuited turn of brass or some resistance material which encloses part of the pole face. The alternating flux in the magnet induces a current in this coil which reacts on the iron inclosed by the turn and delays the magnetism in this portion of the pole face behind the magnetism in the unshaded portion. When the shading coil is properly designed, the flux in the shaded part of the pole face is sufficient to hold the load when the magnetism passes through zero in the other portion of the pole face, so that the load is never released and the magnet is very quiet in operation.

IN THEIR present form, electro-magnets in use today represent a great deal of study and experiment to determine the laws and principles that govern their operation. Here, the author discusses briefly some of the elementary properties for the benefit of the plant men using them.

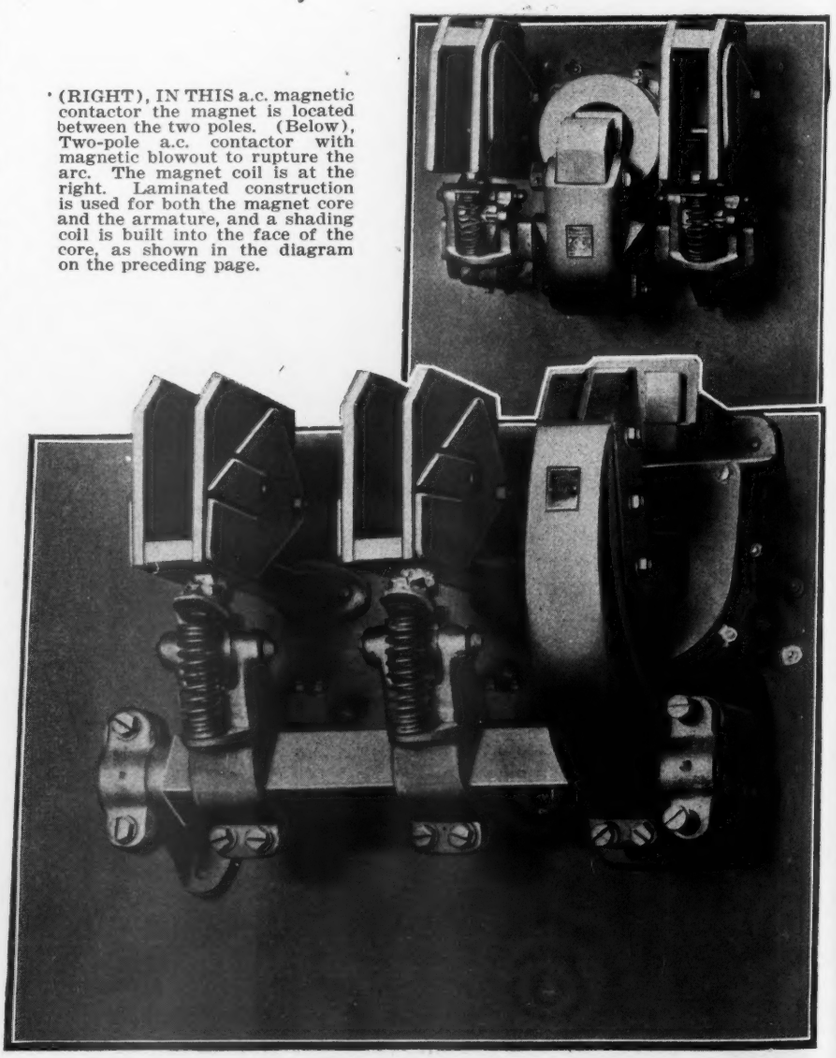
The balance of magnetism between the shaded and unshaded portions of the pole face is rather sensitive and easily affected by a variation in the air gap between the pole faces due to some irregularity in their construction.

In practice both the armature and core have their pole faces ground true and smooth. The armature is then mounted in a flexible manner so that it can find its own seat and is not affected by ordinary variations in manufacture.

The shading coil must develop considerable energy in a small space, so that it frequently runs very hot, but this temperature does not extend far into the iron, as the total energy in the shading coil is relatively small as compared with the mass of the iron. It is, however, necessary to design the contactor so that the shading coil is not close enough to the insulation of the magnet coil to injure it.

In some large magnets, the shading coil circuit is completed through a piece of resistance mounted at the side of the magnet. This permits a relatively large resistor to be used so that the temperature is kept at a low point.

This arrangement is used only where the energy developed in the shading coil is too great to be dissipated in the coil itself, or where the resistance in the shading coil circuit requires careful adjustment.



(RIGHT), IN THIS a.c. magnetic contactor the magnet is located between the two poles. (Below), Two-pole a.c. contactor with magnetic blowout to rupture the arc. The magnet coil is at the right. Laminated construction is used for both the magnet core and the armature, and a shading coil is built into the face of the core, as shown in the diagram on the preceding page.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Charts for Determining the Horsepower of Spur Gearing

By Emory N. Kemler, *University of Pittsburgh, Pittsburgh, Pa.*

THESE charts have been designed to meet the requirements of engineers, shopmen, and others who are interested in eliminating detailed calculations in the selection of gearing.

The following symbols have been used consistently:

N = Revolutions per minute.
n = Number of teeth.
F = Active face width of gear.
D = Pitch diameter in inches.
V = Pitch velocity in feet per minute.
P = Diametral pitch.
p = Circular pitch.
S_o = Allowable static stress.
S = Allowable stress at velocity V.
Y = Tooth or Lewis factor.
W = Safe load in pounds gear can carry.

The formulas for strength of gear teeth are developed on the basis of each tooth being strong enough to transmit the entire load. In calculating the power a pair of gears can transmit, it is necessary only to determine the power the pinion can transmit since it is the weaker when the gear and pinion are made of the same material and which is shown by the Y factor being smaller. Otherwise the strength of each must be determined to find the weaker element.

The values of allowable static stress depend upon the elastic properties of the material and the factor of safety used. For cast iron, S_o is taken as 8,000 lb. per sq. in. and for cast steel and medium carbon, cold-rolled steel is taken as 20,000 lb. per sq. in. For values of S_o for various materials see standard handbooks and reference books such as Machinery Handbook, and other references given herein.

The working stress, S, at a speed V is given by

$$S = S_o \times \frac{600}{600 + V} \qquad (1)$$

This is known as Barth's formula and is the result of experience and experiment. Recent tests have shown that values given by this formula are very safe.

Cast-Tooth Spur Gears—Cast teeth may fail by breaking at one corner or by breaking at the root of the tooth. If the face width is greater than $1.4p$ the tooth will be weakest when a concentrated load is applied at one corner.

The maximum safe load a cast gear will transmit when F is greater than $1.4p$ is given by

$$W = \frac{Sp^2}{13.7} \qquad (2)$$

The horsepower it will transmit is given by

$$Hp. = \frac{WV}{33{,}000} = \frac{p^2V}{33{,}000 \times 13.7} \times S_o \times \frac{600}{600 + V}$$

(1) Norman: Principles of Machine Design, pp. 327-329.
(2) Leutwiler: Machine Design, Chapter 12.

It will be noted that the face width of the gear does not enter into the formula except that the formula is based on F being greater than $1.4p$. In practice F is usually made greater than $2p$. Chart I shown on the next page is based on a value of S_o equal to 8,000 lb. per sq. in. for cast iron.

Cut-Tooth Spur Gears—Accurately made cut gear teeth will usually operate with contact across the entire face width. The load on the teeth will then be evenly distributed and not on one corner as with cast gears.

The maximum safe load a gear tooth will carry with the load distributed over the entire face is given by

$$W = \frac{YFS}{P} \qquad (2)$$

The horsepower is given by

$$Hp. = \frac{YFV}{P \times 33{,}000} \times S_o \times \frac{600}{600 + V}$$

Charts II and III have been constructed for cut tooth spur gears and will be published in an early issue. Chart II is for 14½-deg. standard, involute, cut-tooth, cast-iron gears with a value of S_o equal to 8,000 lb. per sq. in. Chart III is for 14½-deg. standard, involute, cut-tooth steel gears with a value of S_o equal to 20,000 lb. per sq. in., and for the Nuttall 20-deg. involute, stub-tooth gear system with a value of S_o equal to 20,000 lb. per sq. in. The Y factors for the Nutall 20-deg. stub-tooth system are about an average of the Y values for the various stub-tooth forms in the Fellows system. The power as given for a stub-tooth gear of the Nuttall system can be taken as an approximation of the strength of the Fellows sub-tooth system. To get the exact value the proper Y factor must be used for the particular tooth proportions.

These charts have been constructed for a face width of one inch or F equals 1. To find the horsepower for any other value of F multiply the value of the horsepower found from the chart by F.

Example for Chart I—The dotted line on Chart I has been drawn for the following example. It is required to find the horsepower of a 28-tooth, 1-in. circular pitch cast gear having a 2-in. face and running at 100 r.p.m. when S_o is 8,000 also 20,000 lb. per sq. in.

Since F is greater than 1.4 p use Chart I and start on the left at 28 teeth; trace to specified pitch, then down vertically to the stated speed. The pitch velocity V is found to be 235 f.p.m. To find the horsepower trace to the right to intersect circular pitch line and then down. The horsepower indicated refers to S_o at 8,000 lb. per sq. in. To find the horsepower when S_o equals 20,000 lb. per sq. in. multiply the horsepower indicated by 20,000 and divide by 8,000. In this case the horsepower will amount to 7.5 which value would be for a cast-steel gear.

(Chart I on next page—Charts II and III will appear in a later issue.)

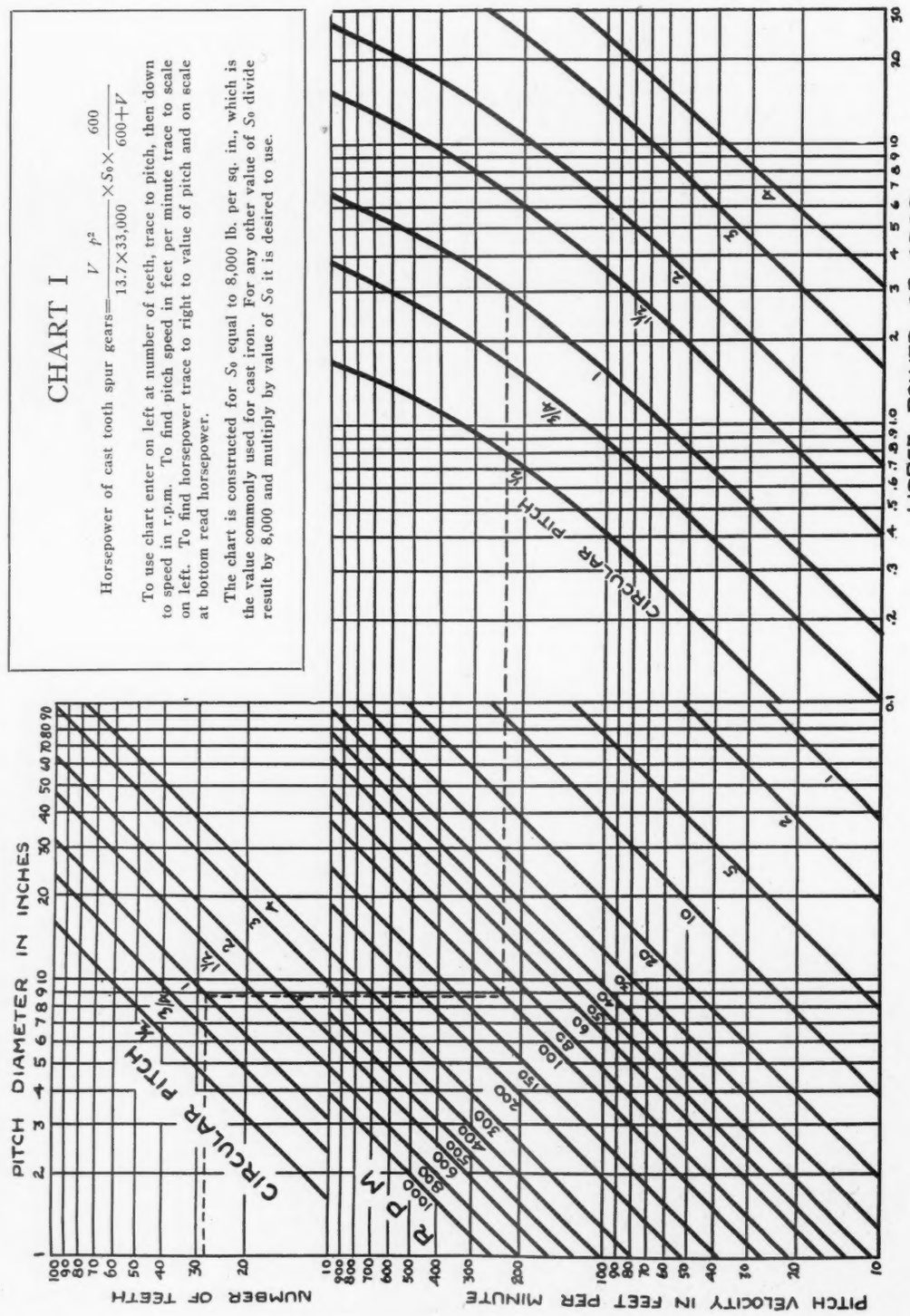
INDUSTRIAL ENGINEERING'S DATA SHEETS

CHART I

Horsepower of cast tooth spur gears $= \frac{V \; p^2}{13.7 \times 33{,}000} \times S_0 \times \frac{600}{600+V}$

To use chart enter on left at number of teeth, trace to pitch, then down to speed in r.p.m. To find pitch speed in feet per minute trace to scale on left. To find horsepower trace to right to value of pitch and on scale at bottom read horsepower.

The chart is constructed for S_0 equal to 8,000 lb. per sq. in., which is the value commonly used for cast iron. For any other value of S_0 it is desired to use.



POWER TRANSMISSION

Through Chains

By WILLIAM STANIAR

Chairman of the Advisory Board
Power Transmission Association
Power Transmission Engineer
E. I. du Pont de Nemours & Company and Subsidiaries, Wilmington, Del.

DURING the past 25 years the transmission of power by chain has progressed rapidly, so that today there is a type and design of chain for almost any installation.

The general advantages of chain driving, where applicable and when the proper type or design is selected for the specific installation, are as follows:

1. Certain types are approximately 98 per cent efficient.
2. Relatively high speeds can be obtained.
3. Can be run in either direction.
4. Are not affected by heat, cold or moisture.
5. Certain types will transmit, within reason, any amount of power.
6. Give a positive velocity ratio.
7. Can be used on short or long centers.
8. Chains cannot slip.

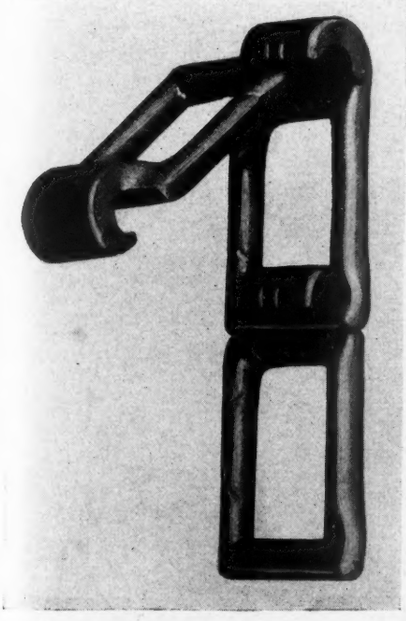


Fig. 2—Malleable-iron power chain of the detachable type can be assembled or taken apart by simply bending the links and separating them, as shown here.

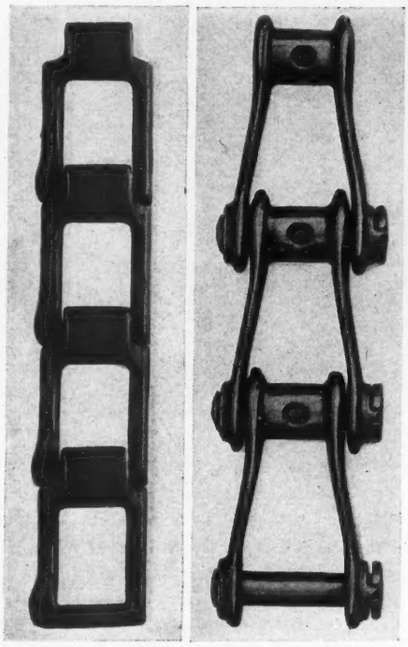


Fig. 1—The detachable type of malleable-iron power chain is shown at the left. The chain at the right is another and stronger type of malleable-iron chain.

* * * *

Detachable Malleable-Iron Chain.—This type of driving chain was introduced in 1873 and since has been constantly improved and its use extended. It is manufactured in approximately 25 stock sizes designated by number. This type of chain is shown in Fig. 1. In the view at the right a stronger design, obtainable in either riveted or detachable types, is shown.

It is composed of individual malleable-iron links so designed as to allow the ease of assembly illustrated in Fig. 2. This method of assembly is applicable to all sizes of this style of chain.

This type of chain finds application in practically every industry where the speeds and ratios are held within the limits herein set forth. In Fig. 3 is shown a typical installation.

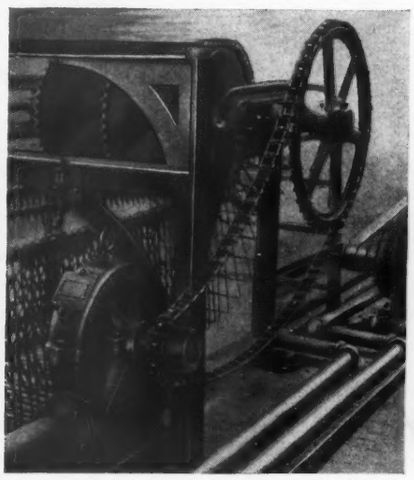


Fig. 3—A typical installation of a malleable-iron power chain.

* * * *

The most desirable ratio of sprockets for this type is not more than 5:1. Higher ratios have a tendency to shorten the life of the chain. In selecting sprockets avoid, wherever possible, the use of less than 10 teeth in the smaller wheel.

Although malleable-iron chains have given satisfactory service for the transmission of power in their field, a demand for chains that would operate at higher speeds and carry heavier loads was responsible for the development of a more accurately made steel chain. These chains range from a rugged, low-speed class to machine-finished, high-speed chains, all accurate as to pitch and of proper design and materials to give long life.

Light-Steel-Roller Chain.—This type of power chain, as shown in Fig. 4, is an accurately-pitched chain of light construction, having three times the tensile strength of the malleable-iron type, and operates on the same cast-tooth sprockets that

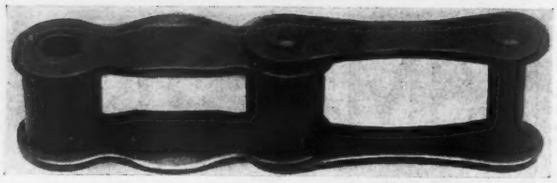


Fig. 4—The light steel-roller power chain.

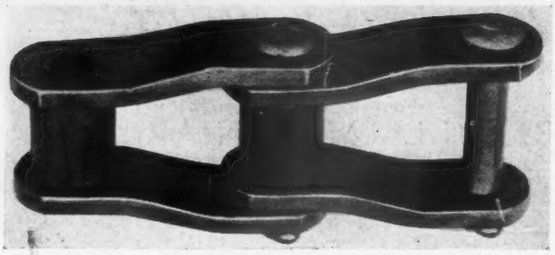


Fig. 5—Heavy type of steel-roller power chain.

are employed with malleable chain.

It is constructed with medium-carbon, hot-rolled steel side bars. The pins and bushings are of hardened steel. The rollers are of either malleable iron or hardened steel, depending on the service requirements. The most desirable speed for this type of chain is 700 f.p.m., or under.

The most desirable ratio of sprockets for this type is not more than 5:1. Higher ratios have a tendency to shorten the life of the chain. In selecting sprockets, avoid, wherever possible, the use of less than 10 teeth in the smaller wheel.

Heavy-Steel-Roller Chain. — This type of power chain, Fig. 5, is a more rugged construction of an accurately-pitched steel chain. It is operated on standard cast-tooth sprockets of similar design to those used with the malleable and light-steel-roller chains. This type is suitable for moderately high-speed drives and is manufactured in a number of convenient sizes.

This chain is constructed of high-carbon steel side bars. The pins and bushings are case-hardened steel and the rollers are of mild steel, heat-treated. This chain can be had in either the riveted or detachable type.

It is especially applicable in the cement and sawmill industries although its use is general where rugged service is required and unusual operating conditions exist. The most desirable speed for this type of chain is 700 f.p.m. and under.

The most desirable ratio of sprockets for this type is not more than 5:1. Higher ratios have a tendency to shorten the life. Wherever possible, the use of less than 10 teeth in the smaller wheel should be avoided.

Finished-Steel-Roller Chain.— Chains of this type, shown in Fig. 6, are intended for general power-transmission purposes and are designed to operate on accurately-cut sprocket wheels. The field of application for all steel roller chains is generally the same and, although this type of finished-steel-roller chain and cut-tooth sprockets involves greater initial cost, it has demonstrated its ultimate economy compared with the less costly, steel-roller chains that operate on cast-tooth wheels. This chain is suitable for moderately high speeds and is manufactured in a number of convenient sizes ranging from ½ to 4 in. in pitch.

It is constructed with special rolled-steel, heat-treated side bars. The pins are made from alloy steel, hardened, and the bushings are steel, casehardened. The rollers are high-carbon steel, heat-treated and can either be made curled or solid. This type of chain can be had either riveted or detachable and is made in single or multiple widths.

Although it is possible to operate finished-steel-roller chain at speeds as high as 1,000 f.p.m., it is much more desirable from an economical and long-life standpoint to limit them to approximately 700 f.p.m. operating speed.

This type of chain allows a wide range of ratios and has been successfully operated with ratios as high as 10:1. The average commercial requirements, however, vary up to 7:1. All things being equal, a chain of this type operated on very small wheels will not last as long as a chain run on fair-sized wheels. For general work, use wheels with 15 teeth or more and never less than 11 teeth, if possible. On wheels of equal diameter, a short-pitch chain of proper strength will last longer than a chain of coarser pitch. For quiet operation and greater durability, a short-pitch, multiple-width chain is often preferable to a single-width, long-pitch chain.

Fig. 6—The finished-steel-roller power chain.

Owing to its strength and accuracy of design this type of chain is applicable to all manner of industrial driving when within the speeds and

Fig. 7—Here a finished-steel-roller chain serves as the second reduction in a lineshaft drive.

ratios mentioned. Fig. 7 shows a finished-steel-roller chain acting as the connection between a silent-chain-driven headshaft and a lineshaft.

Multiple-Strand Finished-Steel-Roller Chain.—Finished-steel roller chain when manufactured in multiple strand, Fig. 8, can be employed as a power transmitter from high-speed motors. A chain of this character should not, however, be operated at higher speeds than approximately 2,000 f.p.m. Multiple chains are manufactured up to six strands in width, have a range of pitch from ⅜ to 2 in. and a range in power capacity up to 150 horsepower.

In Fig. 9 is shown a 50-hp., 1,160-r.p.m. motor driving a lineshaft through two, four-strand chains.

When operating at high speeds. such as 2,000 f.p.m. this style of chain should have an oil-retaining casing.

In addition to its application in general power transmission, this type of chain is also being utilized in speed-reduction units. Fig. 10 shows a compact unit of 46-hp. rating with a 46:1 reduction ratio.

Silent Chain.—This type, shown in Fig. 1 represents a distinct class of power-transmission chain. Engineering skill has been responsible for its development into a most efficient power transmitter. Today this form of drive can be manufactured for almost any reasonable power capacity with a sustained efficiency of approximately 98.5 per cent. It can be run at any practical speed desired and is now very generally employed in connection with motor applications.

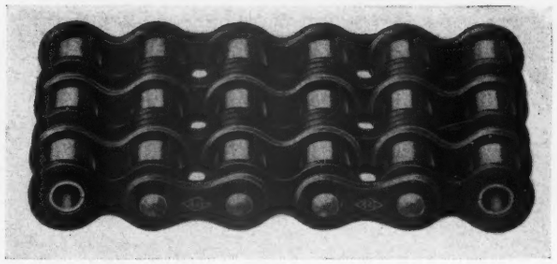


Fig. 8—Multiple-strand, finished-steel-roller chain.

The silent chain is an assembly of specially-designed links that operate on mating, cut-tooth wheels. The most important mechanical operation of this type of chain, however, is the compulsory flexing of its assembly of links at the joints or pins; therefore, the construction of the link-and-pin joint has reached a high stage of perfection.

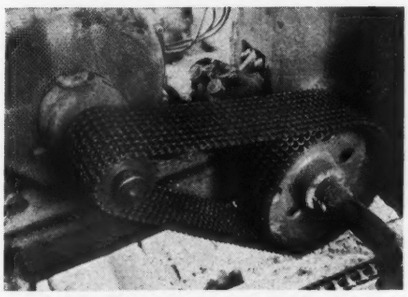


Fig. 9—This double, four-strand finished-steel-roller chain transmits 50 hp. The speed of the motor is 1,160 r.p.m.

* * * *

The single-pin construction of joint is shown in Fig. 12. Fig. 13 illustrates the pin-and-bushing type of joint. Fig. 14 shows one type of rocker-pin joint.

The sprockets for this type of chain are generally termed pinion and gear. When pinions have fewer than 25 teeth of any pitch they are usually made of steel; consequently all silent-chain pinions for motor application are of this material. The silent-chain gears, which are usually the driven wheels, are generally made of cast iron and can be had either split or solid.

The silent chain drive is applicable in all industrial operations, and is particularly adaptable for direct-chain connection between motor and machine or motor and line-, head-, or countershafting, as shown in Fig. 15. For installations such as these it permits the use of short centers, which make for compactness, although it is not confined to short-center driving, because it operates equally as well on any practical driving center.

In Fig. 16 is shown a 50-hp. drive with the upper half of the oil-retaining casing raised. Fig. 17 shows a tandem-chain installation of 800-hp. capacity (the top portion of the oil-retaining casing has been removed).

The most desirable speed for a silent chain is 1,200 to 1,500 f.p.m. This chain may be used at speeds less than 1,200 f.p.m., but as the speed decreases, the size of chain and, therefore, the initial cost of the installation, increases. At speeds higher than 1,500 f.p.m. a silent-chain drive should be incased, to assure proper lubrication.

The most desirable ratios for silent-chain drives range from 1:1 to 7:1. Ratios as high as 15:1, however, have been used successfully. In selecting sprockets for this type of chain, avoid, wherever possible, the use of less than 17 teeth in the smaller wheel. This applies to any pitch.

Tension of Chains.—It is not possible to state any definite rule for chain tensions. The advisable tension depends upon the class of work done, upon the length of the chain, and upon the position of the drive. A short or vertical drive requires finer adjustment than one running in an oblique or horizontal position, where the weight of the chain forms an automatic chain adjuster. As a

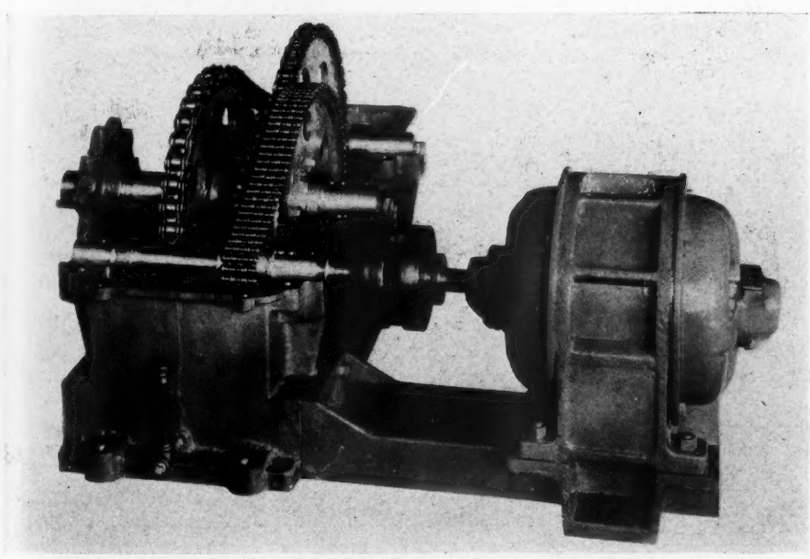


Fig. 10—Finished-steel-roller chains are also used in speed reduction units.

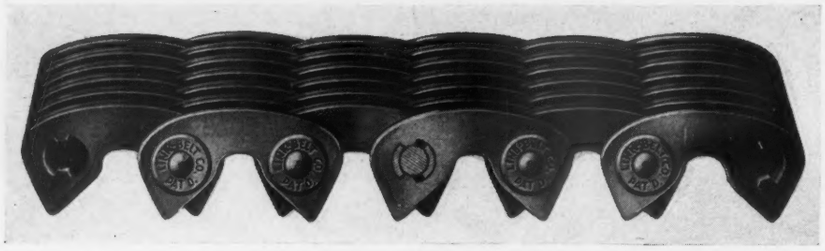


Fig. 11—This power chain is of the so-called silent type.

general rule, however, the chain should be run at a tension which would be considered just too slack for a leather belt. It is always advisable to have one shaft movable so as to be able to adjust the center distance between sprockets.

Care and Lubrication of Power Chains. — The severe conditions under which most chains are now employed make exacting demands not only on the manufacturer of the chain, but on the user. The former should produce the best chains possible, but the consumer must also keep the chain clean and well lubricated.

Chains for driving in industrial operations do not always receive the care they should. They are often run without lubrication, in grit and dirt, and allowed to strike against obstruc-

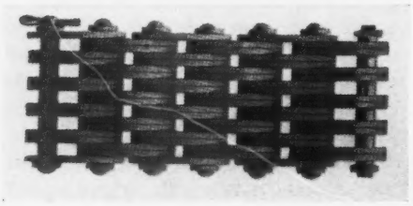


Fig. 12—A single pin is used as the joint in this silent chain.

* * * *

tions. Then, when premature failure occurs, the chain is blamed. Chains are composed of a great number of small parts (particularly the silent type) which, even under reasonable loads and speeds, are not large when compared to the pulls exerted. Lack of lubrication will, therefore, quickly lead to damage of the hardened bearing surfaces, and when these are once destroyed no subsequent attention can restore them. The malleable-iron detachable link, the light-roller, the heavy-roller, and the finished-roller chains should all receive lubrication attention regularly, and the silent chain, for most efficient operation, should be operated in a bath of oil. Oil-retaining steel casings such as are shown in Figs. 16 and 17 are provided by all manufacturers of this type of power-driving chain.

Fig. 13—In this silent chain a pin and segmental bushing constitute the joint.

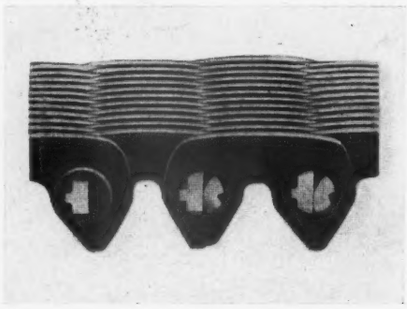


Fig. 14—A silent chain using rocker pins of special design as the joint.

The following rules and formulas will be found very useful in selecting cast-tooth sprockets for malleable-iron link and steel-roller chains.

When the smaller sprocket is the driver, use not less than 12 teeth if possible.

When the smaller sprocket is the driven, use more than 12 teeth if possible.

When revolutions per minute of the driver and driven shafts are the same, use at least 17 teeth if possible.

The large sprockets should not have more than 60 teeth.

In any drive there are four ratio factors: The revolutions per minute of each sprocket and the number of teeth in each. Knowing any three factors the fourth may be found by the following formulas:

$$\text{R.p.m. of driven sprocket} = \frac{\text{r.p.m. of driver} \times \text{no. teeth in driver}}{\text{no. teeth in driven}}$$

$$\text{Number of teeth in driven sprocket} = \frac{\text{r.p.m. of driver} \times \text{no. teeth in driver}}{\text{r.p.m. of driven}}$$

$$\text{R.p.m. of driver sprocket} = \frac{\text{r.p.m. of driven} \times \text{no. teeth in driven}}{\text{no. teeth in driver}}$$

$$\text{Number of teeth in driver} = \frac{\text{r.p.m. of driven} \times \text{no teeth in driven}}{\text{r.p.m. of driver}}$$

Where speeds for both shafts are known, but neither sprocket is selected: The revolutions per minute of the higher-speed shaft divided by

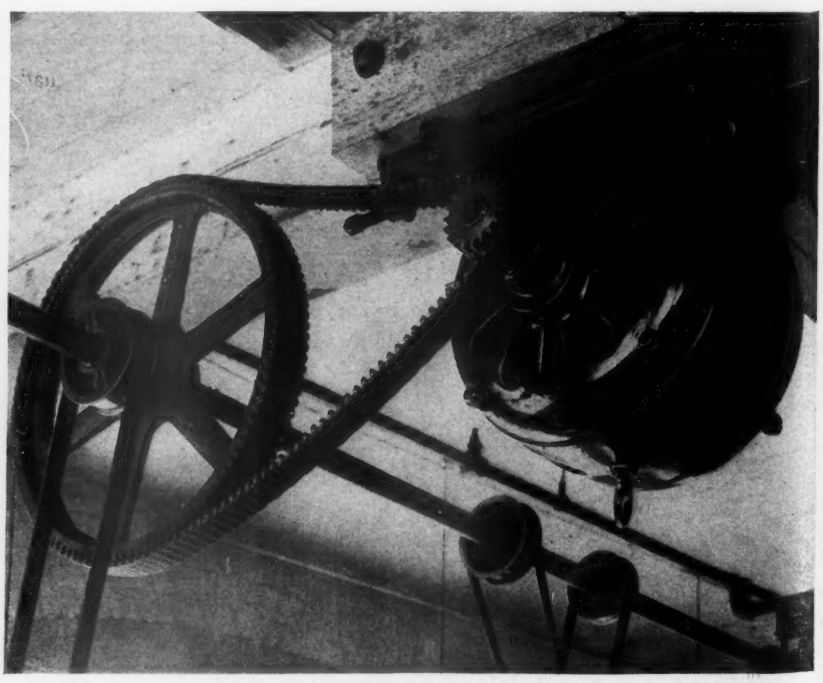


Fig. 15—A silent power chain connects this motor to the lineshaft which it drives.

that of the lower-speed shaft gives the ratio. Ascertain the number of teeth in the sprocket for the higher-speed shaft from sprocket fulfilling horsepower requirements and multiply by the ratio to get number of teeth for the slow sprocket.

Selection of Chain-Drive Centers.—The center distance should be at least equal to the pitch diameter of the large sprocket plus one-half the pitch diameter of the smaller. Some drives must, of necessity, be operated on shorter centers, but this reduces the contact between the chain and teeth of the smaller sprocket, resulting in shorter chain life. Avoid drives with extremely short or long centers.

Relative Position of Sprockets.—Chain drives on cast-tooth sprockets will operate satisfactorily with almost any ratio and relative position of sprockets, and furthermore, with the slack side either on the upper or the lower side.

When the center of the large sprocket is directly over that of the smaller, the drive cannot run with much slack in the chain. As a chain elongates with wear, it will be necessary to make frequent adjustments of center distance or use an adjustable idler on the back of the chain to take out the slack and preserve the proper contact of the chain with the small sprocket. If this drive can be slightly inclined, it will require less care and adjustment.

Fig. 16—A 50-hp. silent chain with the upper half of the oil-retaining steel casing raised.

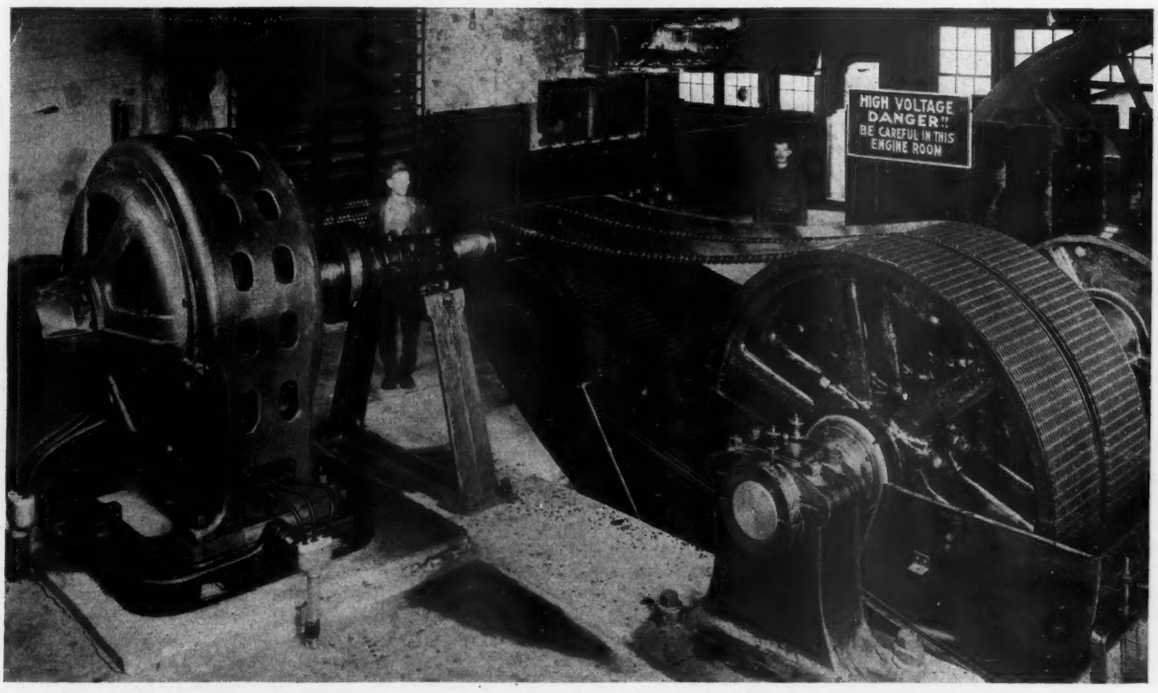


Fig. 17—This tandem silent chain transmits 800 hp. The upper half of the oil-retaining casing has been removed to show the chain.

QUESTIONS
Asked and Answered
By Readers

[HERE IS A PLACE *where you can get some inside information when you get stuck. The only condition is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*]

Is the Distance Between Centers Suitable for This Drive?

Plans have been made to install a 150-hp., 580-r.p.m. motor carrying a pulley 24 in. in diameter to drive a lineshaft at 278 r.p.m. A 50-in. pulley will be used on the lineshaft, and we will use a composition belt 3/8 in. thick and 18 in. wide. As now specified, the center distance between the motor shaft and lineshaft is 12 ft. 6 in., which I feel is too short for a drive of this size. If I am correct in this, what is the minimum center distance that would be satisfactory? As our space is limited, it may not be possible to use the desirable center distance. In that event, what would readers suggest as the most suitable type of drive?

Newark, N. J. L. W.

Changing Speed and Voltage of Large Motor

We have a Westinghouse 250-hp., type HS motor wound for 550 volts, 490 r.p.m., three phase, 60 cycles. There are 144 slots in the stator, with a total of 144 coils. There are three and four coils per group. The coils lie in slots 1 and 7, and the winding is connected two-parallel-star. Can this winding be reconnected for 440 volts, 570 r.p.m., three phase, 60 cycles? If so, what changes will have to be made in the present winding, and what horsepower would be developed under the new conditions? A. A.

Chicago, Ill.

Flooring for Acid Conditions

What types of floors have readers found to be most resistant to acid conditions? In one of our departments considerable amounts of nitric and sulphuric acids are used. Some acid is splashed on the floor and, although it is well diluted with water, it is strong enough to attack wood, so that within a comparatively short time a wooden floor is rotted out. Painting does not stop this action, although it retards it somewhat. We tried putting a coating of asphalt over a wooden floor, but the results were not satisfactory, as the asphalt bulged out and pulled away in numerous places. We have thought of using a brick floor, but do not want to incur the expense of laying it unless we are sure that it will solve the problem.

Elizabeth, N. J. W. H. F.

Increasing Speed of Spot-Welding Operation

Will someone tell me how long it should take a 15-kw. spot welder to weld a piece of 12-gage sheet iron to a strip of 3/16-in. iron, when it is operating properly? This is one of our operations at the present time, but if we use sufficient current to make the weld in less than ten seconds it will burn a hole in the 12-gage sheet. On the other hand, allowing ten seconds or more for each weld slows up our process too much. I shall appreciate any help you can give me on the possible cause of our trouble and how it can be remedied. J. R. H.

Peoria, Ill.

Will a Larger Motor Be Needed on This Job?

We use a boring machine that has two main shafts, each of which is driven separately at a speed of 1,500 r.p.m. by a 20-hp., 1,500-r.p.m. motor, through a belt. Each shaft carries 24 bevel gears, which in turn drive 24 bits, all of the same size. Would it be possible to replace one of these 1,500-r.p.m. motors with a 20-hp., 750-r.p.m. motor, using a 24-in. pulley on the motor shaft and a 12-in pulley on the machine shaft to obtain the proper shaft speed? Or would I have to use a 750-r.p.m. motor of more than 20-hp. rating? In other words, will the necessity of increasing the motor shaft speed also make it necessary to increase the horsepower rating of the motor used? Perhaps some of your readers have experienced a similar problem. C. H. F.

Wilmington, Calif.

Laying New Cement Surface on Old Foundation

About four years ago we put in a number of outside concrete ramps, sidewalks and runways between buildings. For the past year the finished surface of much of this concrete work has been cracking and coming loose from the base, which appears to be the usual crushed stone and cement mixture and is standing up well. Some of the runways have been subjected to fairly hard service from electric and hand trucks, but on the sidewalks and in other places the traffic has been light, although cracking of the surface is about as severe here as elsewhere. I should like to know (1) what has caused the trouble. (2) As the foundation has a rough surface and seems to be in good condition, would it be advisable to lay a new surface over it? That is, would the new surface adhere to the foundation strongly enough to stand an ordinary amount of usage?

Detroit, Mich. J. C. R.

Replacing Batteries for Plant Telephone System by D. C. Generator

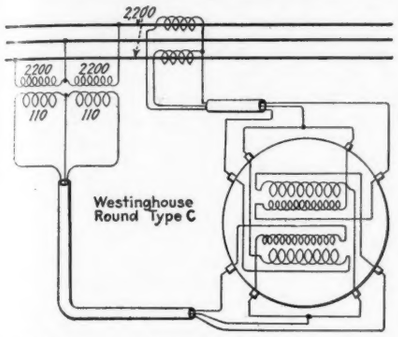
Our plant is divided into four sections, each having its own telephone system. One of these is a full metallic system. The others are selective ringing and talking, but have common returns. In the superintendent's office there are four separate telephones, one for each system; frequently three of them are in use at the same time, but we do not wish to have the systems communicate with each other. Current for ringing and talking is now obtained from dry cell batteries, each system having its own batteries. The telephones are of the push-button type commonly used in offices. We want to replace the batteries by a d.c. generator; can we use one generator for all four systems and avoid interference between them, or should each system have its own generator? Will these telephones work satisfactorily directly from a generator? W. L. B.

Quebec, Ont., Canada.

ANSWERS *Received to Questions Asked*

Testing Meter Without Checking Connections

On a 2,200-volt, three-phase, three-wire delta circuit, the three wires from the potential transformers are run through one conduit and the three wires from the current transformers are run through another conduit to a Westinghouse type C polyphase watthour meter. It is not at all convenient to trace or ring out the wires to the metering transformers so cannot some reader advise me of another method to test for proper meter connections? Due to the changing load it is impossible to tell whether the power factor is above or below 50 per cent.
Cooperhill, Tenn. E. A. M.



Meter connections as they now are on a changing power-factor load.

REPLYING to E. A. M., I assume that his watt-hour meter is at present rotating, but that for some reason he desires to check the connections. Incidentally, I note that in the diagram accompanying this question, the upper current coil is connected to the potential leads, and the potential coil is connected to the current leads. This would, of course, result in a short circuit on the potential side connected to the current coil.

As the Westinghouse type C polyphase watt-hour meter rotates to the right when correctly connected, it will be well to keep this in mind during the following tests. Also, remember that a polyphase watt-hour meter is simply two single-phase watt-hour meters combined under one cover. In this case both elements are arranged in a vertical position, each element having its own disk, and both disks being arranged on one shaft, which is geared to one dial face.

It is obvious that with the correct connections the torque of each element will rotate the disks to the right; also, should one coil only be correctly connected, and its torque be greater than the incorrectly-connected element, the meter will rotate to the right, but at a greatly reduced speed.

Before E. A. M. commences with the following tests, I would advise him to test the voltage at the meter terminals, to ascertain that the required voltage is present. Then take note of the speed at which the meter disk is rotating.

If the required voltage is impressed on the potential coils, short circuit one current coil, for example between terminals *A* and *B* of the accompanying sketch.

On a balanced three-phase load with the power factor between 60 and 100 per cent lagging, the following results may be obtained irrespective of which current coil is shorted out:

1. The disk speed will be reduced to one-half speed.
2. The disk will remain at the same speed.
3. The disk will stop.

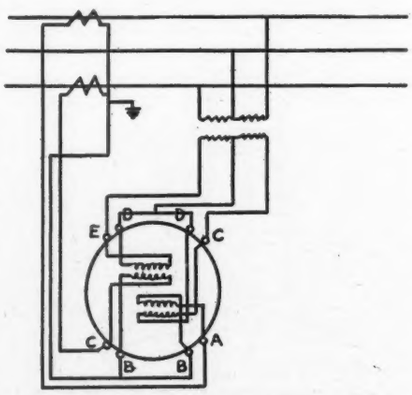
The causes of the above results are:

1. The meter is apparently correctly connected, and by shorting out one current coil you make that element inoperative; hence the speed of the meter is dropped to one-coil operation.
2. This would indicate that the meter wiring is at fault, or that the coil which is shorted is at fault. It is obvious that, with one element connected correctly and the other incorrectly, when the latter is short circuited there will be no effect on the meter.
3. This indicates the same trouble as outlined in *2* only that the correctly-wired element is short circuited.

The remedies for these conditions are:

1. It would be well to change the shorting loop from terminals *A* and *B* to *B* and *C*. Should the same results be obtained it shows that the meter is *OK*., providing it is free from error.
2. Again change from *A* and *B* to *B* and *C*; should the meter stop it will prove that the torque of the element supplied by terminals *A* and *B*, *C* and *D* is neutralized by a bucking effect between the current and the potential therein.

In this case transpose the wires connected to terminals *C* and *D*. By doing this the direction of flow of the potential will be changed to correspond with that of the current. With the short-circuiting wire removed from the meter, the disk should rotate at twice the speed first observed.



Connections for polyphase watt-hour meter on three-phase, three-wire circuit.

3. In this case also change the short-circuiting wire to the opposite current coil. With this done, the meter would be under the same condition as outlined under *2*; that is, the meter will not change its speed. In this case interchange the wires on potential terminals *D* and *E*. The meter should now double its speed.

In regard to correct phasing, I would suggest that E. A. M. change potential terminal *C* to *E*, and terminal *E* to *C*. Assuming the meter to be correctly wired before the change is made, this change will stop the meter, indicating cross-phasing.

After applying the above tests should E. A. M. not be satisfied with the consumption recorded by his meter, I would suggest that he short circuit the current transformers, remove the meter, put it in first-class condition, and then test it against a reliable rotating standard for accuracy.

E. J. ELVISH.
Maintenance Inspector,
Kaministiquia Power Company, Ltd.,
Fort William, Ont., Canada.

Running Distribution Lines When Frequent Changes Are Necessary

The seasonal nature of our product and continual enlargement of the plant necessitate frequent and radical changes in layout. Sometimes whole departments are completely changed or moved to another location. Many of our machines are individually driven, some of the motors being of 40-hp. rating. At present all of the power and lighting lines are run in conduit, but the heavy cost of putting up and tearing down our conduit installations makes me wonder if anyone has devised a method or system of running power lines that permits changes in layout at low cost. I wish that readers who have to meet the problem of frequent changes would tell how they run their lines so that the cost of such moves can be kept down. R. F. B.
Grand Rapids, Mich.

IN his question R. F. B. brings up the matter of frequent changes in the layout of circuits run in conduit. It is admittedly a difficult problem to provide for the removal and reinstallation of electrical circuits, especially when they are installed in rigid metal conduit, without a high scrap loss.

In general, the problem may best be compromised in the usual industrial building by the installation of one or more "trunk" feeders along the ceiling on the longitudinal axis of the building. Pull boxes may be installed at each bay of the building. Risers from motor control groups may be extended vertically to the pull box provided for the section. The size of the wire for the risers must be determined by the Code.

The conduits may be either rigid or flexible, depending on conditions, and may be designed so that they are of uniform length and may be removed

ANSWERS *Received to Questions Asked*

for re-use. The leads from the control to the motor should be type BX or BXL, armored, steel-covered conductors which may be reclaimed and used again. Such a plan cannot be followed where rigid conduit is employed on account of the numerous bends usually necessary in running the conduit to the motor.

Emphasis should be placed on the design of the control panels so that any control in the group may be changed in capacity or removed, and should permit the addition of extra panels. This plan can be accomplished by the use of pipe framework for supporting the control. When induction motors are used a pipe frame 7 ft. high will usually accommodate an inclosed safety switch and compensator. The entire frame may be picked up with the equipment intact and moved to a new location.

To facilitate alterations the feed to each control should enter the top of the switch box so that the feed may be disconnected, taped and pulled out while hot, if necessary. The pipe frame may be made up from standard switchboard pipe fittings. It makes a neat appearance and renders every part of the installation accessible for cleaning and repair. Also, it is fireproof.

Electrical Engineer, J. ELMER HOUSLEY.
Aluminum Company of America,
Alcoa, Tenn.

What Causes Poor Starting of This Motor?

We have a G. E., 30-hp., 220-volt, 900-r.p.m., Type K2-10A, Form K, wound-rotor motor from which we removed the sliprings and shorted the slipring connections. We now find that sometimes the motor will not start until the rotor is moved slightly. When the rotor is not on this particular spot the motor will start and when it comes up to speed the pulling power is normal. We have tested for shorts and grounds and could not find these or any other defects. Can any readers tell me the cause and remedy for this condition?
Logan, W. Va. B. S.

WITH reference to B. S.'s question, if a wound-rotor induction motor has its sliprings removed and the rotor leads connected together, or if the sliprings are short-circuited on themselves, the motor will in general operate like a squirrel-cage motor except that difficulty may be experienced in starting the motor. This is due to what are known as "dead points," where the rotor will lock in position.

In Fig. 1 there is represented a portion of a rotor and stator of an induction motor with each rotor slot exactly opposite the iron of the stator, and every stator slot opposite the iron in the rotor. If in an induction motor the number of rotor slots exactly equals the number of stator slots, there will be as many dead points as there are rotor or stator slots. In order to avoid this condition, it is usual for a squirrel-cage motor to have the rotor and stator slots prime to one another, so that only one rotor slot can be in the locked position at any instant. This gives the best conditions for starting.

For example, a certain two-pole, 1,500-r.p.m., 25-cycle, squirrel-cage motor has 41 rotor bars and 48 stator slots. If any rotor slot its placed in the locking position with reference to the stator, it will be found that no other pair of rotor and stator slots is in exactly this position, although several may be close to it.

As a matter of fact, if not more than about one-sixth of the slots are in the locked position at any one time, reasonably good starting torque may be expected. As usually designed, a squirrel-cage motor will have about 15 per cent of the full-load torque at starting when full voltage is applied to the stator, irrespective of the position of the rotor.

Now, in the case of a wound-rotor motor, the rotor winding is "phase wound." Instead of having the rotor winding short-circuited by endrings, like the squirrel-cage motor, it usually has a balanced winding wherein the number of slots is evenly divisible by the product of the number of poles and the number of phases. For this reason it is not unusual for a wound-rotor motor to have a considerable number of slots in the locking position at one time.

For example, a wound-rotor motor may have four rotor slots to every five stator slots. If one rotor slot is placed in the locking position, as indicated by a pair of slots in Fig. 1, then every fourth rotor slot will be in the locking position, and if the rotor is placed in the right position, it is possible to have one-fourth of all the rotor slots in the locking position at one time.

This naturally brings up the question, "Why does a wound-rotor motor not have dead points or positions where the rotor locks in position when it is used in the usual way with a secondary resistor and a controller?"

To answer this question, it is necessary to consider exactly what causes a rotor to lock in place when a large percentage of its rotor and stator slots take the position shown in Fig. 1. In Fig. 2 where the rotor iron is opposite the stator iron, there is very little leakage flux. Except for the air gap between rotor and stator, there is an easy path between the stator iron and rotor iron for the passage of magnetic flux, and there is a minimum of zig-zag leakage flux where the magnetic flux passes through the iron and may link

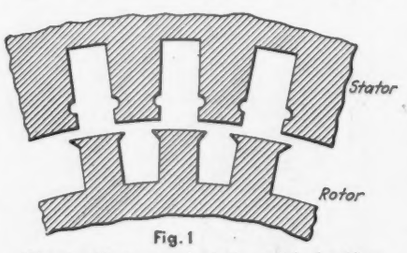


Fig. 1—Rotor and stator of induction motor in position where the slots of each are opposite the iron of the other. In this position leakage flux is at a maximum.

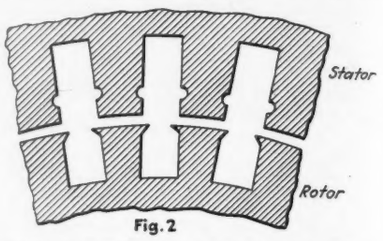


Fig. 2—When the rotor iron is opposite the stator iron there is little leakage flux.

the rotor slots without linking the stator slots, or vice versa.

In Fig. 1, this leakage flux is a maximum and it is this leakage flux that causes the rotor to lock in position. With the rotor stationary and the rotor circuit short-circuited the inrush current is high, possibly six or seven times full-load current, and the corresponding magnetic flux is high, causing the rotor to lock if it is in just the right position. However, as generally used, the slipring motor is started with enough resistance in series with the secondary winding to reduce the inrush current to about 100 per cent value, or if it is used with a crane where low torque is desirable, it may be as low as 50 per cent.

This large reduction in the starting current means a correspondingly large reduction in flux, so that there is no tendency for the rotor to lock in position even though a large proportion of the rotor slots are in the position shown in Fig. 1.

In other words, dead points are caused both by zig-zag leakage flux and by having a large proportion of slots getting into the position shown in Fig. 1.

In the case of the squirrel-cage design, this condition is avoided by using a suitable number of rotor slots as compared with the number of stator slots. In the case of the wound-rotor motor, it is not so easy to do this on account of the phase-wound rotor, but trouble is avoided by the reduction of flux when using a starting resistor.

If it is desired to avoid dead points when a wound-rotor is used as a squirrel-cage motor, a small amount of permanent resistance can be inserted in the motor secondary. This will eliminate the tendency to lock in position, increase the starting torque of the motor, and decrease the starting current, but will reduce the full-load speed.

R. F. EMERSON.

Industrial Engineering Department,
General Electric Company,
Schenectady, N. Y.

AROUND THE WORKS

THIS SECTION *is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.*

* * * *

Simple Water Rheostat for Emergency Service

OCCASIONALLY it is necessary to make use of a heavy current, for example, in burning out or locating short circuits or grounds in a conduit line or piece of equipment, with some simple means of regulating and limiting the current flow. In the absence of better equipment I have several times in emergencies used the simple water rheostat described below with very satisfactory results.

Fill a fiber or wooden pail nearly full of water, to which should be added one-half pint of muriatic acid or one or two handfuls of common salt. The purpose of the acid or salt is to make the water a better conductor of electricity.

A piece of No. 8 or 10 B & S gage insulated wire should be firmly connected to a piece of sheet iron, or any good-sized iron part. When nothing else was available I have used one-half of a small shaft coupling. This electrode should be placed at the bottom of the pail and the wire attached to the line or equipment to be tested. A similar electrode should be connected to one side of the power supply. The other side of the power circuit should be connected to the other line under test.

The water rheostat is thus in series with the line, and by cautiously dipping the second electrode into the water in the pail a current of varying strength can be allowed to flow through the apparatus under test.

With a little experience one can determine about how much salt to put in the water to vary its conductivity, so that fairly close regulation of the current flow can be obtained. Current flow is also regulated, of course, by raising or lowering the upper electrode.

Chief Engineer, ALBERT BOURDO.
Mt. Tom Sulphite Pulp Company,
Mt. Tom, Mass.

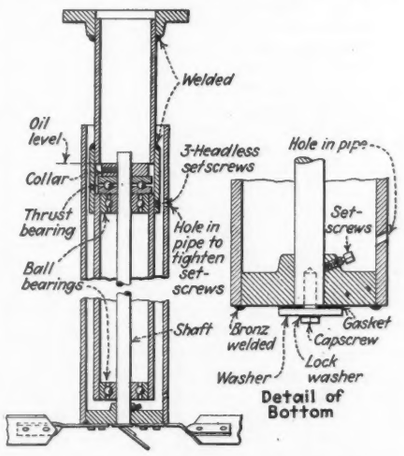
Method of Installing Ball Bearings in Vertical Ceiling Fans

ANY bearing to run smoothly and quietly must have sufficient oil. Formerly the bearings of vertical fans which were driven from lineshafts were always troublesome because the oil reservoirs around the bearings were drained dry by gravity. This trouble has now been completely overcome and the bearings always run in oil.

We accomplished this by obtaining ball bearings of such outside diameter that they fitted snugly into the ends of extra-heavy steel pipe after boring it out slightly.

The pipe carrying these bearings is inclosed in an outer pipe which has a blank bronze-welded in one end. This blank is bored to the size of the shaft which passes through the ball bearings. Details of this fitting are shown in the illustration. This outer pipe serves two purposes—as a pulley and as an oil reservoir. Two holes must be drilled in it; one near the top and in line with the headless setscrews in the pipe coupling; the other is near the bottom and in line with the setscrew in the hub of the blank. These holes are tapped and fitted with screws to prevent oil leaking.

To assemble, the inner pipe with its ball bearings is slipped down over the shaft in the outer pipe. The ball thrust bearings and retaining collar respectively are placed on the shaft. Next the pipe having the coupling bronze-welded on one end is screwed onto the outer pipe and the headless setscrews tightened through the hole in the outer pipe. This hole is then plugged with a screw to prevent the escape of oil.



THE BEARINGS are fitted into the ends of a piece of extra-heavy pipe. A piece of larger diameter pipe which slips over the other, serves as the oil reservoir and also as the pulley.

* * * *

Magnolia, Miss. W. T. CLAYTOR, JR.

Hasty Diagnosis of Electrical Trouble Does Not Pay

ONE time I went out to a brick yard about 30 miles from the city to straighten out a small d.c. generator that was not operating properly. It was belt driven from a small engine and was of about 10-kw. rating. The load consisted of the plant lights, one 5-hp. hoist motor, and one or two electric drills.

The machine would not generate at all; so I checked the fields and found that the shunt leads were reversed. We connected them properly, and when the engine was started again the machine built up properly and all the lights burned brightly. Someone replied in the affirmative to my inquiry as to whether all the load was connected.

After the machine had been running for a few minutes we left, but had not been gone very long when a load was ready to be hoisted. Then it was found that the motor would run, but just as soon as the load was applied the voltage would die down and the generator would cease to deliver current. Obviously, the machine had been left with the series field bucking the shunt field. Of course, so long as there were only a few lights burning and very little current flowing, the machine would operate as a shunt generator. However, when the hoist motor was started and something like full-load current flowed in the generator series field, it neutralized the effect of the shunt field and the voltage would die down entirely.

Another trip then had to be made to the place and the series field was reversed so that it assisted rather than opposed the shunt field.

If we had only stayed a little longer on our first trip a good deal of time would have been saved, as we could have cleared up the trouble at once. It is seldom, if ever, good policy to leave a repaired machine or a new machine too quickly after it is supposedly operating properly.

Birmingham, Ala. GRADY H. EMERSON.

Method of Demagnetizing Motor Shafts

SOMETIMES motor and other shafts became magnetized to an objectionable extent and some means of removing the magnetism must be adopted. In such cases the following method can be recommended:

Remove the pulley from the end of the shaft. Obtain a coil of wire containing several hundred turns, and with an inside diameter large enough so that the coil can easily be slipped over the end of the shaft The size of the wire is not very important, and a suitable coil can usually be found on the "odds and ends shelf" or "under the bench" in the electric repair department of almost any plant. If the coil happens to be wound with a small size of wire, it can probably be connected directly across the line; if the wire is so large that too much current will be drawn, the current can be controlled by means of suitable resistance.

With the coil supported on the end of the shaft, and evenly spaced around it, connect the terminals of the coil to a d.c. circuit of 110 or 230 volts. The current flow should not be more than 4 or 5 amp. By closing the switch in the circuit to the coil, we put a direct current through the coil, which in turn magnetizes the shaft strongly. This can be tested by holding a piece of steel near the end of the shaft.

Next, open the switch in the circuit to the coil, and place against the end of the shaft a piece of steel that is of such size that it will be held there by the magnetism now existing in the shaft.

Now change the connections of the terminals of the coil, so that the current will flow through the coil in the opposite direction.

If the switch is closed as now connected, the shaft will become magnetized to the same strength as in the previous operation, except that the polarity will have been reversed. It will be clear that in order to reverse the magnetic polarity of the shaft, the original polarity must be opposed by a new magnetic influence sufficiently strong to overcome it and develop the opposite polarity. Hence, there must be a point during the reversal of the magnetism where the two forces are equal and, therefore, neutralize each other; that is the point where the shaft will be demagnetized.

It is assumed now that the shaft has been magnetized by the first flow of direct current through the coil; the switch has been opened, the terminals of the coil reversed, and a piece of steel held against the end of the shaft by magnetism.

Now, just touch the switch contacts in the closed position, allowing a very slight flow of current through the coil; make this contact as short as possible, and if the shaft has been demagnetized the piece of steel that was clinging to it, has now dropped to the floor, indicating that the magnetism has been neutralized.

This method is absolutely certain, and its success depends only upon carefully giving, as required, one or more very slight "kicks" to produce the opposite magnetic polarity.

HARRY W. BENTON.
Plant Engineer,
Pratt & Whitney Co.,
Hartford, Conn.

Easy Method of Stripping Stators and Armatures

THERE are a number of methods of stripping motors, varying from the rather primitive method of pulling each coil and sometimes each wire out by hand, to those that make use of special lye solutions, and so on. We have found that an inexpensive way is to turn the stator on end and if necessary set it on bricks. Then, after placing some kindling or other inflammable material in the core, with oil spread liberally over the winding, we set fire to the whole.

After the stator has cooled sufficiently, the operator snips off the noses of the coils on the lead end with tin snips or bolt cutters and removes a sample coil to serve as a guide in setting the coil winder and puller.

This method does not require much attention if the burning is done in the yard of the shop or plant. Almost all shops are so located that outside burning is feasible; if not, a home-made furnace can easily be set up.

This method is practicable on ordinary motors, but is, of course, useless if the motor has been wound with asbestos wire or has been impregnated with a heat-resisting varnish such as the so-called phenol-resin base varnishes. In such cases the use of a lye bath constitutes the best method of loosening the coils. After a lye bath, the stripped equipment must be thoroughly cleaned.

Many times an armature is easier to strip by hand, with the aid of a coil bar, burning out the old cell papers with a gasoline blow torch later on. Sometimes we have found it necessary to cut off all the leads first, remove the commutator, build a little oven of loose brick around the armature, whose shaft is supported on bricks, and then burn the insulation out as in the case of stators. Care must be taken to turn the armature at intervals to prevent warping of the shaft.

Building a fire under an armature or stator may seem to be drastic treatment, but there is no possibility of danger to the laminations, shaft or frame, if the cooling is not hurried, but is allowed to take place slowly at atmospheric temperature.

Denver, Colo. CARL A. WAGNER.

When Supply Lines Go Hay Wire

WE HAD an unusual experience recently on our 33,000-volt transmission line which is a wooden pole line consisting of three No. 1 aluminum steel-core cables mounted on angle-iron cross arms carrying three-phase supply at the stated voltage from one of our power houses situated eighteen miles away, to the substation in the mill.

A farmer was hauling in a load of hay underneath the lines when a whirlwind lifted two or three hundred pounds of hay from the top of his load carrying it up in the air and allowing quite a cluster of it to drop across the wires. The hay being dry apparently did not affect the system as we were unaware of its presence there until the following day, when we had a shower just before noon. At 1:30 p. m. there were several, very heavy surges on the system tripping out all the generator circuit breakers. An investigation disclosed that some local people observed several vivid flashes where the hay was on the line, at the same time that the surges occurred on the system, so undoubtedly, the hay when wet formed a leakage path between the lines.

Although experiences of this kind may not be unusual on some of the larger systems, it is the first trouble of its kind we have had, so we pass this information along for the benefit of any of the readers who might be interested.

F. WHITELEY,
Power Engineer.
Dryden Paper Company, Lt'd.,
Dryden, Ont., Canada.

—Reports of other unusual occurrences are always welcome.—The Editors.

Muslin Screens to Keep Plant Dust from Drafting Rooms

THE smoke from the coal- or oil-burning furnaces and other equipment used in industrial plants deposits a good deal of soot in the offices around the plant and is especially troublesome in design and drafting work.

In an office occupied by the writer we placed oilcloth covers over the drawings at the end of the day to keep them clean. The office doors and windows were fitted with fine copper mesh screens.

Later on, we found that the best way of keeping out soot and dust was to use muslin in the screen frames, which can be made the full size of the window, or as small as desired.

The muslin cloth has several advantages over copper screen wire, in addition to costing only a fraction as much. The big point in favor of the muslin is that it lets in more light, and at the same time filters the air free of dirt.

Muslin screens can, of course, be used not only in separate office or other buildings, but drafting rooms, offices or laboratories located in the same building as a shop can be protected by fitting muslin screens to all windows.

Washington, D. C. G. A. LUERS.

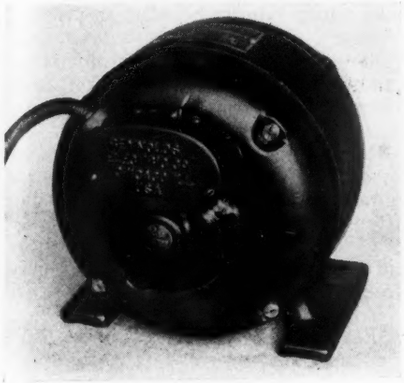
NEW EQUIPMENT

For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Reynolds Type C Motor

A MOTOR fitted with a built-in switch which facilitates easy starting and stopping has been introduced by the Reynolds Electric Company, 2650 West Congress St., Chicago, Ill. This feature, it is stated, eliminates the necessity of plugging in the current connection.



Reynolds Type C Motor

The motor is practically inclosed but adequately ventilated with a free circulation of air. The temperature rise is well under 40 deg. C. Some of the features that the manufacturer emphasizes are: Frame of machined cast iron; stator of punchings pressed together under heavy pressure and riveted; rotor of indestructible squirrel-cage type with copper end rings electrically welded to copper bars; and windings of cotton-covered enameled copper wire, carefully inserted in the insulated slots of the stator and held in place by heavy wedges.

The motor is finished in black enamel, baked on.

Brooks Visualizers Merge with International Visible Systems

SOLE right to the use of the name "Brooks Visualizers" (visible record equipment in book form), a product of the Brooks Company, Cleveland, Ohio, has been acquired by the International Visible Systems Corporation, Cincinnati, Ohio, manufacturers of visible record equipment in cabinet form, as the result of a recent merger of the sales and executive forces thereof.

According to the announcement, the purpose back of the combination is to provide an unbiased service through which the proper system and equipment are fitted to each particular record problem as it stands; that is, visible books where the system's application requires books for speed and economy and visible cabinets where cards are faster and cheaper. Offices are located in important business centers throughout the country.

Westinghouse Meter Service Breaker

A POSITIVE, automatic, circuit breaker, designated as the WK-50 Meter Service Breaker, has been developed by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., for use on 30-amp., 125-volt, two-wire, solid neutral service.

The breaker is operated by a quick make-and-break toggle switch, thus eliminating contact burning and variable action. The insulated handle can be locked or sealed in the off position is desired. The box is of the usual form and dimensions, with arrangements made for ordinary meter trims and banking troughs.

Westinghouse WK-50 Meter Service Breaker

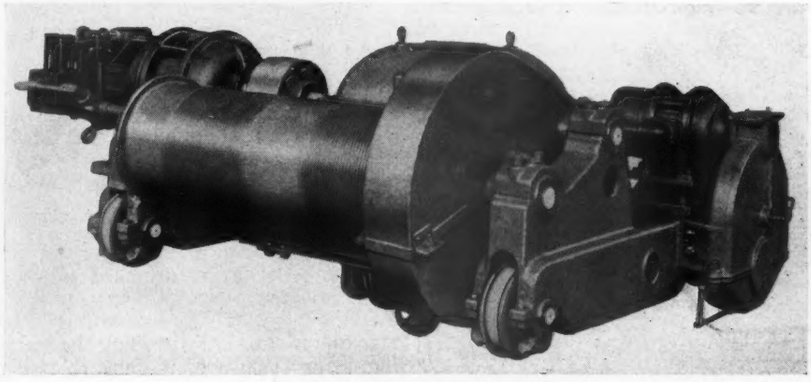
Since there is no need for access to the circuit-breaker mechanism, it is sealed inside an insulating cover. This feature prevents tampering and helps in keeping out dust and dirt.

The self-heating, bi-metal operating the latch on the breaker will not fuse on any overload current that can be obtained at the rated voltage. In case of mechanical failure this U-shaped bi-metal acts as a link fuse and opens the circuit without injury to other parts of the breaker. It has been accepted by the Underwriters' Laboratories and bears their label as a device approved for entrance use as required by the National Electrical Code.

Niles Improved Crane Trolley Design

IN the trolley design brought out by Shephard Niles Crane & Hoist Corporation, Montour Falls, N. Y., all the operating mechanism is totally inclosed. The high-speed reduction gear between the hoisting motor and cable drum, as well as the load brake, are inclosed.

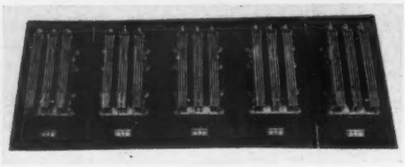
The final, or slow-speed reduction to the cable drum is inclosed with a cover and the reduction gear drive from the trolley motor is protected with a cover. Small removable plates are provided on the casings so as to facilitate inspection. With this construction all gears are adequately protected from dirt and the high-speed gears and load brake are maintained in proper alignment.



Niles Crane Trolley

Champion Disconnecting Switches

THE 4,000-amp., 4,500-volt disconnecting switches shown, have been introduced by the Champion Switch Company, Kenova, W. Va., and are of the back-connected, single-throw type



Champion Disconnecting Switches

for mounting on slate, marble, or soapstone bases.

The blades are of the tongue type and are provided with positive safety locks.

Gerrard "TA" Metal Tie Binding Method

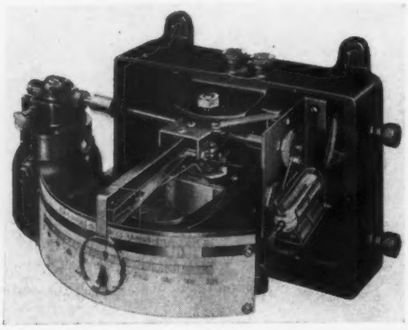
A METAL tie binding method has been developed by the Gerrard Company, Inc., 1942 S. 52nd Ave., Chicago, Ill. Wire is looped around a package, threaded through the machine and the tie completed with one throw of the lever forward and backward, which tensions, seals and trims the ends.

Republic Control Pyrometer

A COMBINATION of pyrometer control apparatus and mercury switch designed specifically for the control of electric furnaces and any type of fuel-burning furnace has been brought out by the Republic Flow Meters Company, 2240 Diversey Parkway, Chicago, Ill. The system may be applied to other control applications, to draft, pressure, etc. The outstanding feature of the control, according to the manufacturer, lies in the elimination of the usual open metallic contacts and the relays that previously have been required for controlling electrical loads of any magnitude. A gas-filled mercury switch is used that will handle currents up to 25 amp. at 220 volts.

The pyrometer is of the standard Republic high-resistance, double-pivoted millivoltmeter system. The control mechanism is a purely mechanical device that might be described as a "selector" system or as a reversing clutch system. It consists of a small synchronous motor operating by a simple mechanical motion in such a way that the position of a power lever is determined by the position of the sensitive pointer. A thermocouple is used to operate a millivoltmeter movement in the instrument. When the needle corresponds with the control point, which is set on the indicating dial by means of a target, the depressor mechanism, operated by the small synchronous motor, is not permitted to descend on its periodic depression.

A crank arm direct connected to the motor lifts the lever that throws the switch on and off. This crank arm is guided by a selector cam, whose position is in turn determined by the position of the depressor. When the temperature is below the given setting, the depressor passes the pointer on its downward stroke and sets the crank arm so that it turns the switch on. The switch then remains in this position until the temperature rises and the pointer intercepts the depressor, preventing it from completing the downward stroke. The crank arm then takes a different position and operates a trip lever that throws the switch off.



Republic Pyrometer with Motor-Driven Depressor and Mercury Switch

General Refractories High-Temperature Cements

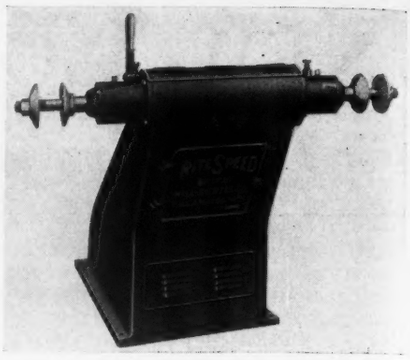
THE General Refractories Company has adopted a policy of selling their high-temperature cements, GREFCO Chrome High-Temperature Cement and STANDARD Silica Bonding Cement through dealers in all industrial centers throughout the country.

Hill-Curtis Polishing and Buffing Lathe

ONE of the features of the "Rite Speed" electric polishing and buffing lathe, recently introduced by the Hill-Curtis Company, Kalamazoo, Mich., is the rigid one-piece base and spindle support having overhanging spindle design, allowing maximum working clearance around the spindle. There is a clearance of 12½ in. from the spindle housing to the front of the pedestal, at the floor.

The motor is mounted on the inside of the pedestal on T slot rails and designed to form a hinged bracket, permitting belt tension adjustment from the outside of the pedestal in the rear, without disturbing the motor mounting. Louvers are provided to insure circulation of air.

The Hill-Curtis combination switch and brake is also furnished on this model, reducing wheel change time to a minimum, says the manufacturer. The machine is started by pushing the starting lever backward, thereby releasing the brake, and throwing the remote switch to the "on" position. By reversing this action, the lever is pulled forward, breaking the current circuit, and applying the brake. Push-button control can be furnished, if preferred.



Hill-Curtis "Rite Speed" Electric Polishing and Buffing Lathe

This machine, like all Rite Speeds, transmits the power from the motor to the spindle by means of Multi-V belts which require no idler to prevent slippage.

The oversize one-piece chrome-manganese spindle is supported on four oversize ball bearings or Timken roller bearings, as preferred.

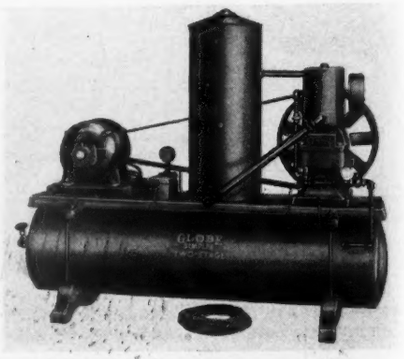
Removal of the belt may be accomplished by taking out the four large cap screws on each side of the spindle, after which the entire spindle assembly can be removed from the pedestal without disturbing any of the sub-assembly units.

The lubrication system includes convenient oil cups, oil level gage, and flushing plug.

Globe Air Compressor Unit

A COMPACT air compressor unit designed for heavy duty and known as the Simplex Type W, Two-Stage, Water-Cooled Victory Unit, has been developed by the Globe Manufacturing Company, Battle Creek, Mich. The unit has a cooling system designed for operation with running water where continuous pumping is required, or with thermosiphon circulation for intermittent duty.

The complete outfit consists of a vertical air compressor, motor, a 30-gal. water-cooling tank and an automatic



Globe Simplex Type W, Two-Stage, Water Cooled Victory Unit

controller with pressure unloader mounted on a steel air storage tank equipped with a heavy iron base and feet. Included also are a 300-lb. pressure gage, 25 ft. of air hose with chuck and coupling attached, a safety valve, a check valve and fittings.

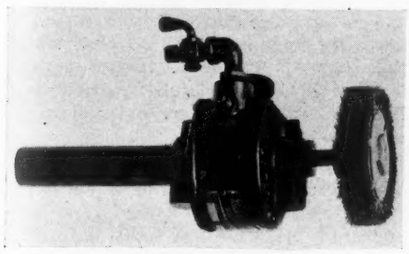
The motor and the compressor are connected by an endless belt. A Globe patented, automatic, sliding motor base maintains the proper belt tension, it is added.

The air storage tank is guaranteed for 200 lb. working pressure. In addition to the automatic pressure controller, d.c. outfits include an automatic rheostat and a.c. outfits include an automatic starter which permits the motor to be thrown directly across the line.

Paasche Air Motor Brush Cleaner

A LIGHT and simple air-operated cleaning brush designed for removing rust, scale and old loose paint preparatory to painting has been introduced by the Paasche Airbrush Company, 1909 Diversey Parkway, Chicago, Ill. The device consists of a circular steel wire brush driven by an air motor.

The brushes are available in two sizes, 4 in. in diameter by ¾-in. face



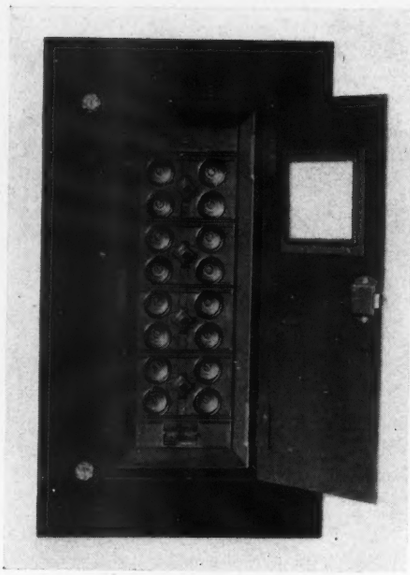
Paasche Air Motor Brush Cleaner

and 6 in. in diameter by 1-in. face. The net weight is 10 lb. and the dimensions are 11 in. long by 4½ in. in diameter. This unit is recommended by the manufacturer especially for use in connection with all air painting equipment used by railroads, paint contractors and manufacturers of steel products where the cleaning of surfaces before painting has always been a problem.

Square D Narrow Panelboard

WITH the introduction of a full line of narrow lighting panelboards, the Square D Company, Detroit, Mich., adds another product to its line of electrical control equipment.

These boards are 12 in. wide over all (6-in. panel and 3-in. gutter all around), which allows them to be used in places where a larger panelboard could not be conveniently installed (on supporting steel girders, in factories, for example). They can be supplied with cartridge fuses, as well as plug fuses. Switched circuits, as well as fuses only, can be supplied in the branches.



The Square D Narrow Panelboard

There are six different wiring combinations possible with this panelboard. All molded parts are of genuine Bakelite, olive-green Duco finish, sectional construction, with all sections mounted on channel-irons, trim clamps, and chromium plated hardware. Spring-catch locks are standard equipment.

Where both switches and fuses are supplied, the switches are of the tumbler-type, heavy-duty, 30-amp., 250-volt rating—exactly the same as used in the standard panelboard. Mains are of 30- to 100-amp. capacity. The branches are all 30-amp. capacity. The number of branch circuits obtainable ranges from 4 to 32.

G. E. Instruments to Have "Non-Glare" Glass

USE of a special glass which prevents glare is one of the features of an added line of instruments for switchboards introduced by the General Electric Company, Schenectady, N. Y. The special glass, in combination with anti-parallax scale and pointer, facilitates reading regardless of the angle from which the instrument is viewed.

In this line the instruments are uniform in size and appearance for both alternating-current (Type AD) and direct-current (Type DD) ammeters, voltmeters, wattmeters, reactive volt-ampere meters, power-factor meters, and frequency meters. They are listed in standard commercial frequencies, but special ratings and scale markings can be furnished.

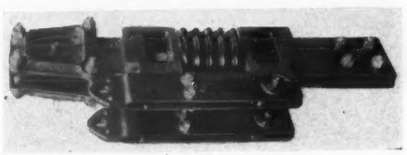
The instruments are 6 in. high, 5½ in. wide and 3½ in. deep, making it possible to mount four instruments across a 24-in. switchboard panel, and to economize on space. They are back-connected, and equipped with mounting studs to support the instrument on the switchboard.

Voltmeters, wattmeters, power-factor meters and reactive volt-ampere meters have the resistors inclosed in the instrument cases, thus further conserving panel space. An exception to this is the wattmeter. For voltages in excess of 140, wattmeters are supplied with external resistors. Both a.c. and d.c. instruments have electromagnetic damping.

G. E. Switchboard Instruments Equipped with Non-Glare Glass

Delta-Star Disconnecting Switch

A DOUBLE-BLADE, tongue-type disconnecting switch, known as the WT-14, designed for clamping directly on bus bars, has been developed by the Delta-Star Electric Company, Chicago,



Delta-Star Disconnecting Switch

Ill. According to the announcement, it affords a convenient method of inserting a disconnect between the oil switch and the bus, thus securing a high space factor and short runs to the oil switch terminal.

Robins Fluted Cleaning Brush

A SPIRAL, fluted-rubber cleaning device for cleaning conveyors, known as the "Squeegee" cleaning brush, has been introduced by the Robins Conveying Belt Company, 15 Park Row, New York City.

The brush, which has been designed to give better cleaning results with less wear on the belt than the former types, consists of a series of spiral flutes made of high-grade rubber. The roll is 7½ in. outside diameter and made up in sections 6 in. long. The sections are mounted on a wooden core the same diameter as used on the older type brushes, so that the brushes now in use can readily be replaced without any change in the driving mechanism.

The rubber cleaner turns with a peripheral speed of about 1,000 ft. per min. The wearing part is about ¾ in. deep.

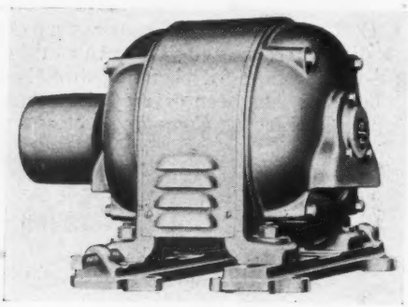
U. S. Uniclosed Motor

AN addition to its line of standard motor designs, known as the Uniclosed Motor, has been announced by the U. S. Electrical Manufacturing Company, Los Angeles, Cal. The Uniclosed Motor has a pressed-steel housing and although not totally inclosed, offers the desired inclosing features.

It embodies a dual fan blast, autostart principle, asbestos protection, solid die-cast aluminum rotor, and ball-bearing application.

Two air streams are drawn through the motor from both ends by high-capacity fans located on opposite sides of the rotor. Each fan creates separate air currents which meet at the middle of the frame where the heated air is expelled on both sides of the motor through dual exhaust louvers.

A feature of the design, according to the manufacturer, is the cover, which can be removed quickly by loosening 4 screws, thereby exposing the air passages for inspection and cleaning. There is no direct exposure of the windings. The internal parts are shielded from water and abrasive substances such as dirt, grit, metal shavings, and so on.



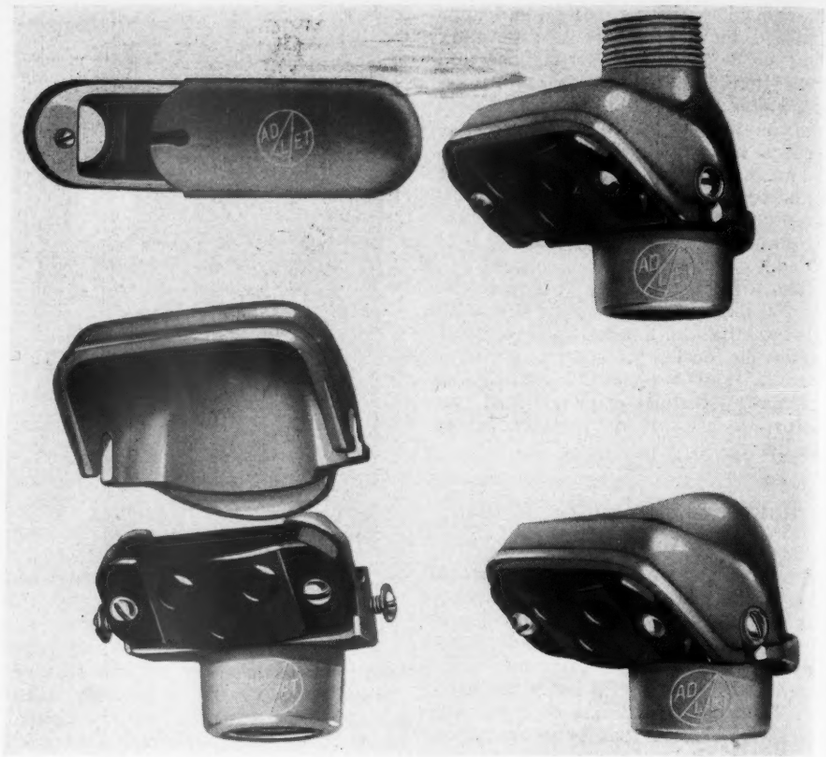
U. S. Uniclosed Motor

The motor is said to be well fitted for use in locations where moisture and dripping water are ever-present menaces to electrical equipment.

Adelet Service Entrance Fittings

THE accompanying illustrations show part of the line of conduit service fittings now being placed on the market by the Adelet Manufacturing Company, 4610 St. Clair Ave., Cleveland, Ohio. With the Service Entrance Fitting it is not necessary to remove the composition cover in order to pull the wires. The fitting consists of two parts, a base and a cap. By loosening the two side locking screws the cap may be lifted off, thus exposing the entire interior of the fitting and permitting a straight through pull on the wires. The cap may be locked in place by merely re-tightening the locking screws.

The Service Entrance Ell holds the conduit close to the building and is made so that the cover is reversible. Both ends of the cover are drilled and tapped for cover-locking screws, and when it is desired to reverse the cover it is only necessary to move the cover-locking screw from one end to the other and tighten up on the screw.

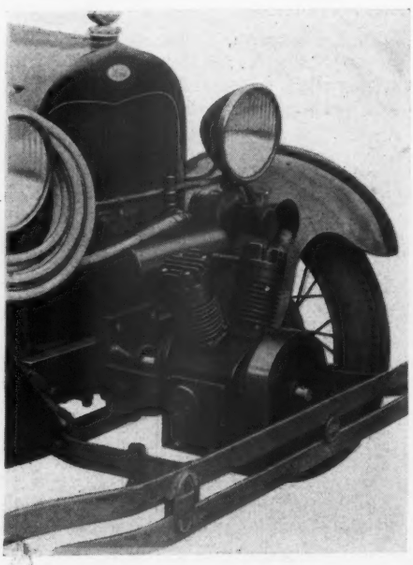


Adelet Service Entrance Fittings

These service ells are also made with a spring locking cover, so that when the cover is closed it cannot be re-opened without so damaging the cover that the tampering is at once apparent.

Globe Portable Compressor

A PORTABLE 2-cyl. air compressor that can be mounted on the front end of an automobile or tractor has been introduced by the Globe Manufacturing Company, Battle Creek, Mich. Among the uses suggested for this unit by the manufacturer are paint spraying for all classes of outside work, the operation of pneumatic tools and many other jobs requiring the use of compressed air in the field or away from a regular source of supply.



Globe Portable Air Compressor for Automobile Mounting

According to the manufacturer, the compressor is light in weight, takes but a small part of the power developed by any automobile motor, and will not strain the car or overload or overheat the engine. The compressor is equipped with Timken bearings lubricated by means of positive oil rings. Standard equipment includes 25 ft. of air hose with chuck, safety valve, and gage.

G. E. Fabricated Terminal Boards

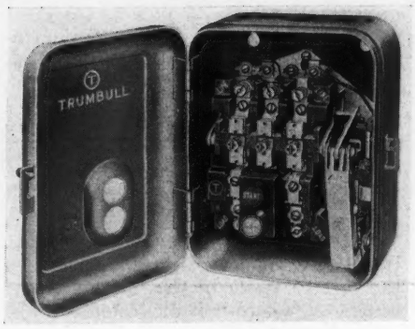
A FABRICATED terminal board recently announced by the General Electric Company, Schenectady, N. Y., is recommended in cases where a large amount of small wiring is used on the back of a panel. It consists of a number of terminal blocks separated by suitable barriers assembled on rods with end lugs for mounting, and white marking strips to enable each circuit to be identified.

By reason of the fabricated assembly, it is claimed, any practical number of poles can be built into a single unit. Standard sizes are 4, 8, 12, 15, 18, 24, 30 and 38 poles.

Trumbull Type M 7½ Magnetic Starting Switch

INTERRUPTING capacity and ease in wiring are among the features emphasized by the Trumbull Electric Manufacturing Company, Plainville, Conn., in introducing the Type M 7½ magnetic starting switch for across-the-line motor starting.

This switch is of a design providing thermal protection against overload or damage due to phase failure, the control of which may be either local, local and remote, or automatic with the change of one connection on the control terminal. Duo-break contacts (wiping movement under pressure) provide high-interrupting capacity, increase overload protection and reduce the arc to 1/20th of the usual single-break construction, it is claimed. The thermostatic control is a permanently built-in thermostat with removable, interchangeable heating elements ranging in capacity from 1 to 20 amp. according to the full load of the motor to be controlled.



Trumbull Type M 7½ Magnetic Starting Switch

The inclosing box, measuring 6½x 8½x4 1/16 in., has ample wiring space on all four sides of the switch. Knockouts are provided on top, bottom, sides and back. However, the line and load connections are straight through from top to bottom.

It is available with a maximum rating of from 1½ to 5 hp. and from 3 to 7½ hp. for polyphase and single-phase, 115-, 230-, 460- and 575-volt circuits, respectively.

Browning Coil Equipment

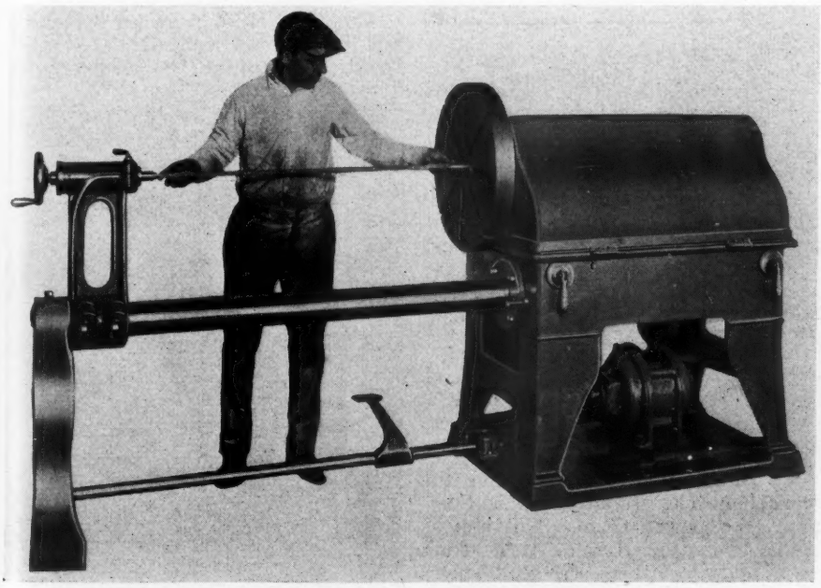
A COMPLETE series of heavy-duty field and transformer winders has been added to the Browning line manufactured by the Mutual Foundry & Machine Company, Atlanta, Ga. This group includes 3 models, Types FA, FB, and FC, especially designed to meet the requirements of field and transformer manufacturers as well as repair shop and maintenance department needs.

Type FB, illustrated, has a swing of 30 in. in diameter over the tail stock bar, and will accommodate lengths up to 48 in. between centers. Two operating pedals are furnished—one of which may be adjusted at any convenient place between the tail stock and face-plate, the other being located close to the driving end. Tail stock and supporting bar may be removed and a maximum swing of 84 in. made available.

Type FC is similar to Type FB, but is suitable for face-plate work only. A 24-in. face plate is standard equipment, having 4 T slots and 4 open slots for ⅝-in. bolts.

According to the manufacturer, the outstanding feature of the Type FB unit in addition to the wide range of speeds available at 8 settings is the ease of set-up and operation. A 5-hp. motor drives a disk clutch through silent chain, and in order to secure positive tension on wires at all times a powerful brake is used which prevents slack wire. The mechanism is balanced so that slight pressure on the foot pedal permits the clutch to pick up the load before the brake entirely releases it, and vice versa. The announcement also adds that sufficient power is available to pull 25 strands of flat copper under tension.

Type FA is essentially the same as the models described, but due to its low bed has a swing of 72 in. All models are equipped with Dodge, Timken, SKF and Hyatt bearings throughout. The Alemite system of lubrication is also used.



Browning Field and Transformer Winder

G. E. Drum Switch Operating Mechanism

THE General Electric Company, Schenectady, N. Y., announces the development of a type of operating mechanism for use with drum switches mounted in crane cabs and similar places. This mechanism, superseding the rack-and-pinion under-lever type, eliminates the trouble experienced in keeping a perfect lineup between the shaft of the operating mechanism and the drum switch shaft, and makes it possible to inclose the mechanism to keep dirt from the gear lubricant.

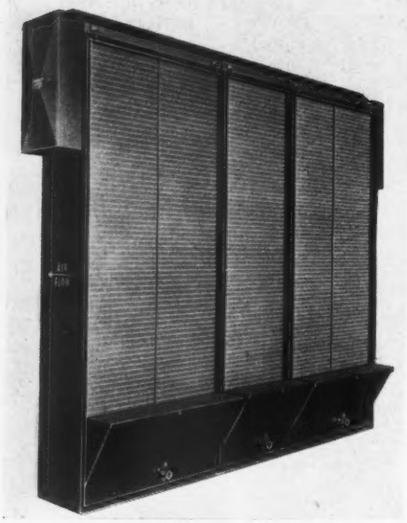
G. E. Drum Switch Operating Mechanism

The mechanism consists of a pinion on an extended drum switch shaft meshing with a segment gear, all housed in a dust-tight cast case provided with plugged access hole for gear slushing and with a short lever arm projecting below the case. The lever arm can be connected with the reach rod in the same way as with the old type.

Some of the advantages of this mechanism are as follows: As the segment gear and its shaft are capable of assembly in different positions, varying by 60-deg. increments the operating lever may be located in other normal "off" positions than the one at right angles to the conventional center line of the switch if required by the peculiarities of the application. By the use of oilless bearing bushings the question of bearing lubrication is disposed of. There are no keys, pins or set screws to work loose and introduce play or back-lash. The gear ratio is such that the movements of the operating lever is very nearly a straight line for the reach rod and is laid out to give a linear travel equal to older designs.

Reed Multi-Panel Air Filter

AN outstanding feature of the improved multi-panel air filter, put out by the Reed Air Filter Company, Louisville, Ky., is the method of separating the panels and cleaning each one individually as it passes through the oil



Reed Multi-Panel Air Filter

reservoir at the bottom of the filter stand. Although developed originally to meet the severe operating conditions and exacting air-cleaning requirements of steel mill service, the filter is adaptable to a wide range of industrial applications. By virtue of its design and method of cleaning, the operating resistance is constant.

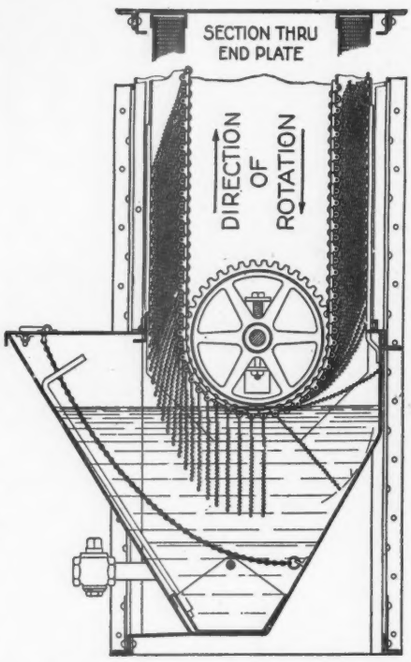
The filtering media consists of a multiplicity of overlapping screen panels that form a continuous movable curtain. To increase the capillary surface effect these panels are coated with liquid bakelite covered with fine fiber and baked in an oven. This forms a porous fibrous coating capable of retaining many times the amount of adhesive that normally would be held on the smooth surface of the bare wire. Naturally the greater the amount of the adhesive oil that the filter media can carry, without danger of entrainment, the greater will be the dust-holding capacity of the filter and the longer it will operate without loss of efficiency.

The panels, which are suspended from horizontal rods carried by two endless chains, overlap each other like shingles on a roof, forming a filtering curtain with a depth of five panels at every point through which the air must pass. The average resistance through the filter is 0.36 in. water gage. The woven wire used for these filtering panels is folded upon itself to give double thickness and double strength. The panels are corrugated horizontally to secure the desired spacing between successive layers, to supply additional voids for dust accumulation and to provide increased filtering area.

The filter curtain operated by a solenoid and ratchet mechanism, in steel-mill service, and by a hydraulic drive in ventilating installations, moves ¾ in. every 12 min. or 3¾ in. an hour. Under severe dust conditions the speed may be increased to maintain a normal operating resistance.

As the panels reach the lower turn they automatically separate and are cleaned, one at a time, by swinging in the oil through an arc of 90 deg. This action loosens and removes the dust accumulation. While in the oil bath the panels hang vertically, permitting the dirt to settle to the bottom of the reservoir, where it is deposited into the sediment pan. The panels leave the oil vertically, being moved up ¾ in. at a time with a 12-min. interval for draining. This action tends to strip off any surplus oil. Each panel drains a total of 1½ hours after leaving the oil before it enters the air stream.

These filters are made in sizes ranging from 5 to 13 ft. high and in capac-



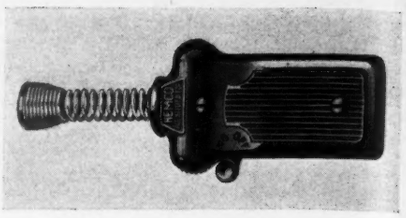
A Sectional View of the Lower End of the Reed Air Filter

ities based on an average air velocity of 500 ft. per min., ranging from 3,000 to 84,000 cubic feet per minute.

A filter of similar construction, with additional reinforcing to withstand the pulsating air flow to compressor and engine services, also is made by the company. Capacities of this filter range from 1,500 to 24 000 cubic feet per min.

Bryant Electric Hemco Switch Plug

A HEMCO switch appliance plug, No. H-260, is being placed on the market by The Bryant Electric Company, Bridgeport, Conn. This plug is made of molded Bakelite with strain relief grooves where the cord enters the plug. These grooves take the strain from the terminals when the



Bryant Electric Hemco Switch Appliance Plug, No. H-260

plug is removed from the appliance by pulling on the cord.

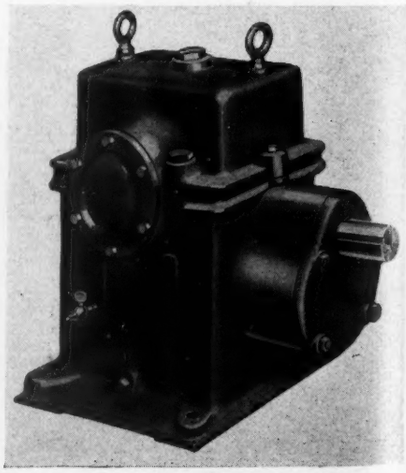
The terminals are self-aligning and automatically adjust themselves to a perfect contact over either round or flat terminal lugs. The self-aligning feature is due to the fact that one side of the terminal is secured in a floating position. On the outside of the plug, non-slip grips are provided on each side insuring easy and quick removal from the appliance. It is claimed that the plug is not affected by heat or moisture and will not break if accidentally struck or dropped.

This Hemco switch plug can be supplied in a cord set. Six feet of cord is included as standard equipment.

Foote Bros. HGX "Hygrade" Worm Reducer

FOOTE BROS. GEAR AND MACHINE COMPANY, 215 N. Curtis St., Chicago, Ill., has developed an addition to their "Hygrade" line of anti-friction worm gear speed reducers, known as the HGX Type, and which is an intermediate step between the HGS single-reduction unit and the HGD double-reduction unit. The HGS single-reduction unit with right-angle drive has a maximum ratio of 58 to 1, at which the maximum efficiency can be obtained. The HGD double-reduction unit provides for all ratios over 58 to 1 and up to 5,000 to 1, but the shafts are parallel.

The Type HGX provides higher reduction ratios than standard ratios listed for the Type HGS reducer and

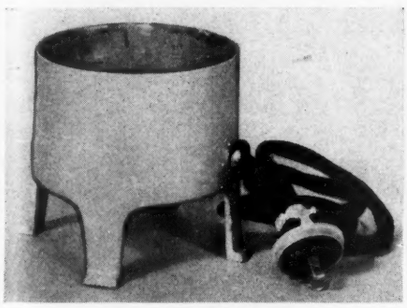


Foote Bros. Type HGX "Hygrade" Worm Reducer

still maintains the right-angle drive where ratios higher than single-reduction ratios are desired. It consists of a standard "Hygrade" single-reduction worm reducer with a set of helical gears mounted on the worm shaft and inclosed in a suitable housing. The high-speed element consists of a set of wide-faced helical gears having a maximum ratio of 4 to 1 or increasing by 4 times the standard reduction ratios of the HGS single-reduction unit. The adopted ratios as standard for the helical gears or high-speed end of this unit are 1 to 1 (to be used only for reversing relative rotation of worm and worm gears) 2 to 1, 3 to 1 and 4 to 1 which is the maximum reduction. The maximum motor speed which can be applied to the high-speed shaft of this unit is 4,000 r.p.m. Like all the other type "Hygrade" reducers, the Type HGX is a fully-inclosed, self-lubricating unit, having anti-friction bearings, bronze worm gear and nickel steel carbonized, hardened, ground and polished worm.

Trent Tinning Pot

MADE only in the single-heat type for 110-volt circuits, the tinning pot illustrated has been placed on the market by the Harold E. Trent Company, 439 North 12th St., Philadelphia,



Trent Tinning Pot

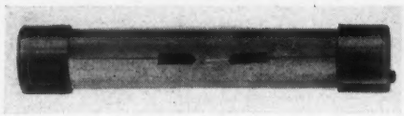
Pa. The pot consumes 355 watts. The inside dimensions are 4 in. in diameter by ½ in. deep. The manufacturer is in a position to supply this pot with a depth of only ⅛ in. if desired.

Martindale High-Voltage Indicator

A HIGH-VOLTAGE indicator consisting of a permanently mounted visible light to show when a conductor is dead or alive has been introduced by the Martindale Electric Company, 1260 West 4th St., Cleveland, Ohio.

The indicator is a sensitive neon discharge tube equipped with special electrodes and assembled in a glass housing capped with brass ferrules. When installed on a line conductor the tube glows at comparatively low voltages.

In voltages between 2,000 and 4,000 a ground connection is used and the tube is set in the looped end of a metal strap, which is in turn wrapped around additional micarta insulation placed on the conductor. When used on conductors carrying a voltage above 4,000 no ground connection is used and no additional insulation is used between the clamp and the conductor. If the

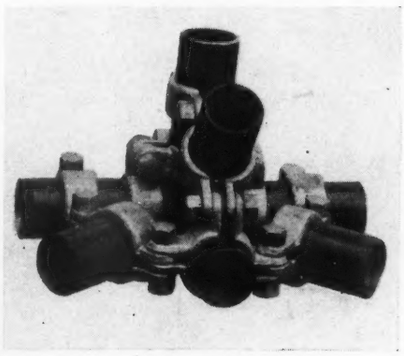


Martindale High-Voltage Indicator

cable is lead sheathed the sheath is removed where the clamp is attached. The device measures 4⅝ in. long by 7/16 in. in diameter.

Delta-Star Uniclamp Pipe Fittings

A LINE of pipe fittings known as "Uniclamp" has been developed by the Delta-Star Electric Company, Chicago, Ill. According to the manufacturer, the main feature is that each fitting has one short ear projection



Uniclamp Pipe Fitting

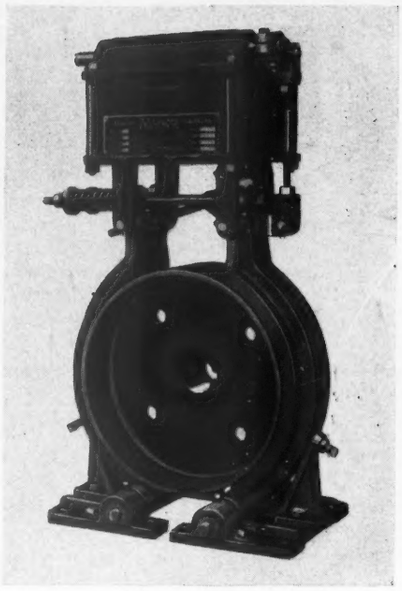
which lines up with the center line of the pipe and a long ear 5/16 in. from the pipe center line.

The long ear of one clamp is always fitting over the short ear of the clamp next to it. The net result is that with five pieces any combinations of pipes or braces can be secured. The clamps are also satisfactory for railing footings where no braces are present.

Mainco A. C. Elevator Brake

AN a. c. elevator brake in which all the operating mechanism is at the top has been introduced by the Maintenance Company, 449-53 W. 42nd St., New York, N. Y. The mechanism is supported by the shoes, so that no separate base or mounting is required, and it is so designed that the magnet and armature hang naturally in the oil reservoir and are removable (with the top) without disturbing the reservoir.

This brake is a companion to Type PD, the Mainco d. c. elevator brake, but it supersedes the Type A for all installations except where there is room at the side of the brake pulley and not enough above.



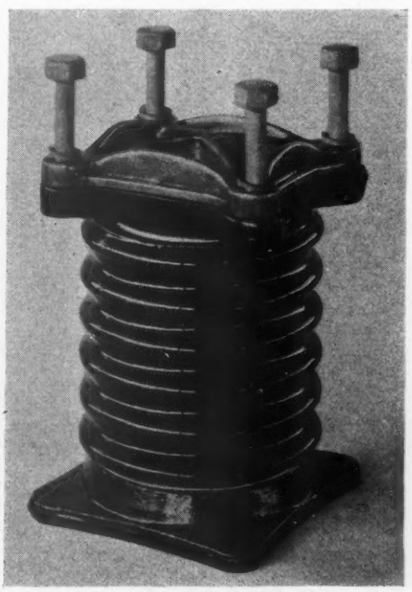
Mainco A. C. Elevator Brake

The shoes are of cast iron, reinforced, and provided with a high-grade lining. They are opened and held opened by an electromagnet acting through a toggle, and closed by strong, flexible, helical springs. The brake has two magnet coils for single-, two- and three-phase operation.

Champion Heavy-Duty Bus Support for Indoor Service

AN improved line of heavy-duty bus supports for indoor service up to and including 25 kv. is announced by the Champion Switch Company, Kenova, W. Va. The porcelain units are furnished in diameters of 4, 5, and 6¼ inches.

The bus clamps are heavily ribbed and will accommodate several bus bars with spacers.



Champion Heavy-duty Bus Support

TRADE LITERATURE
You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

(184) MOTORS—Bulletin No. 102, "A general description of the various types, the advantages of each, and the method of manufacture."—American Electric Motor Company, Cedarburg, Wis.

(185) SPRAY PAINTING—The manufacturers announce the release of Bulletin R, a railroad catalog containing an explanation, by photos and description, of the uses and methods of operating all railroad spray painting equipment.—Binks Manufacturing Company, 3114-26 Carroll Ave., Chicago, Ill.

(186) WATTHOUR METERS—"Registers of Revenue" is the title of an interesting booklet recently released containing a short discussion of the origin and history of watthour meters.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(187) PANELBOARDS—Catalog No. 45 contains listings of the complete line of Frank Adams Standardized Panelboards arranged and indexed for easy reference.—Frank Adams Electric Company, St. Louis, Mo.

(188) AIR COMPRESSORS — Bulletin No. 147 contains an interesting cross section of a single-stage air compressor, together with descriptions and illustrations of Pennsylvania methods of compressor regulation.—Pennsylvania Pump and Compressor Company, Easton, Pa.

(189) PYROMETER—Bulletin No. 400 announces the Type FD Pyrometer, for determining the temperature of molten type metal as used with various type casting machines.—Roller-Smith Company, 233 Broadway, New York, N. Y.

(190) OUTDOOR SWITCHING EQUIPMENT — Folder GEA-1029A, group-operated, rotating-insulator, disconnecting switches. — General Electric Company, Schenectady, N. Y.

(191) TRANSMISSION DEVICES—A 64-page catalog, designated as No. 88, treats of the construction and operating principle, composite designs, remote controls and accessory parts, automatic control, various applications and information on Reeves Variable Speed Transmission. — Reeves Pulley Company, Columbus, Indiana.

(192) WIRING ACCESSORIES—Catalog 14 supersedes all previous listings on safety switches, panel boards, knife switches, wiring devices and switch boards.—The Trumbull Electric Manufacturing Company, Plainville, Conn.

(193) MAINTENANCE TOOLS—General catalog No. 14 shows complete line of electrical maintenance equipment, including commutator undercutting and slotting equipment.—Martindale Electric Company, 1252 W. 4th St., Cleveland, Ohio.

(194) METERS—Bulletin No. 110 describes the Type D Groundometer.—Borden Electric Company, 480 Broad St., Newark, N. J.

(195) WELDING—The complete Torchweld line with cross sectional views of various welding apparatus is covered in a 40-page catalog designated as No. 29.—Torchweld Equipment Company, 224 N. Carpenter St., Chicago, Ill.

(196) PUMPS—"The Secret of Hydraulic Balance," a brief treatise outlining the basic principle of the Blackmer pump. This is in booklet form.—Blackmer Pump Company, Grand Rapids, Mich.

(197) MOTORS—Bulletin L-2, 4 pages, describes the Elliott line of high-speed, high power factor induction motors. Bulletin L-3 describes and illustrates a special type of synchronous motor with flywheel effect for compressor drive.—Elliott Company, Jeannette, Pa.

(198) FIRE-FIGHTING EQUIPMENT—"Modern Fire-Fighting Equipment" is the title of the latest catalog published by this company. The catalog is 176 pages in length and contains listings of practically every kind of portable fire-fighting equipment.—American La France and Foamite Corporation, Elmira, N. Y.

(199) AMMETERS—Bulletin No. 810 covers Types TW, FW, and STW thermo-couple ammeters and milli-ammeters for direct current, and alternating current of all frequencies, including radio frequencies.—Roller Smith Company, 233 Broadway, New York, N. Y.

(200) MOTORS—Seven types of squirrel-cage motors are discussed and compared with each other in the 24-page bulletin No. 165, recently issued, under the headings of general purpose, normal torque across-the-line, low-torque across-the-line, high-torque double squirrel cage, punch press, and elevator types.—Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo.

(201) LUBRICATION — Engineering Bulletin No. D-29, recently issued, is entitled "Diesel Engines and Their Lubrication."—Standard Oil Company (Indiana), 910 South Michigan Ave., Chicago, Ill.

(202) UNIT HEATERS—Bulletin No. 7818 illustrates and describes the 1929 line of Venturafin Unit Heaters. This new series contains 4 sizes with many new improvements.—American Blower Corporation, 6000 Russell St., Detroit, Mich.

(203) ELECTRIC, OIL AND SALT BATHS —A new bulletin on this subject gives some very interesting information on this class of equipment together with many of its uses.—Despatch Oven Company, 622 Ninth St., Minneapolis, Minn.

(204) TRANSFORMERS—Bulletin No. 629 describes Sorgel Air-cooled (dry type) Transformers with conduit connections, ¼ to 50 kva.—Sorgel Electric Company, West Water near Clybourn St., Milwaukee, Wisc.

Coming Events

Illuminating Engineering Society—23rd Annual Convention, September 24 to 27 incl., Bellevue-Stratford Hotel, Philadelphia, Pa., Illuminating Engineering Society, 29 West 39th St., New York City.

National Safety Congress—Eighteenth annual meeting, Chicago, Sept. 30 to Oct. 4.

The National Electrical Manufacturers Association—The annual meeting will be held at the Wardman Park Hotel, Washington, D. C., the week of Oct. 7. Albert Pfaltz, National Electrical Manufacturers Association, 420 Lexington Ave., New York, N. Y.

National Electric Exposition—Oct. 7 to 12 incl., Grand Central Palace, New York, N. Y. Managers, Fred W. Payne and Charles F. Roth, 480 Lexington Ave., New York, N. Y.

American Gear Manufacturers Association—The semi-annual meeting will be held Oct. 24, 25, and 26, Benjamin Franklin Hotel, Philadelphia, Pa. Secretary's office, 3608 Euclid Ave., Cleveland, Ohio.

American Society of Heating and Ventilating Engineers—35 annual meeting, Jan. 27 to 30, 1930; Hotel Benjamin Franklin, Philadelphia, Pa.

International Heating and Ventilating Exposition—To be held under the auspices of the American Society of Heating and Ventilating Engineers, Commercial Museum, Philadelphia, Jan. 27 to 31, 1930. Manager, Charles F. Roth, Grand Central Palace, New York.

National Factory Show—The first National Factory and Industrial Production Exposition will be held in Chicago in the early part of 1930. G. E. Pfisterer, president, The National Factory and Industrial Exposition, 308 West Washington St., Chicago, Ill.